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Volume 36, Number 12 December 2006

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ON THE COVER Turquoise is making a return to its former popularity as a lapidary material. (Photo by Harold and Erica Van Pelt/Bill Larson specimen)

Miller Magazines, Inc.

Rock & Gem (ISSN 0048-8453, USPS 486-250) is published monthly by Miller Magazines, Inc., 290 Maple Ct., Ste. 232, Ventura, California 93003-3517, telephone (805) 644-3824. Periodicals postage paid at Ventura, CA 93006, and additional mailing offices. Single-copy price $4.99. Subscription in U.S.A. and possessions: 1 year (12 issues) for $24.00; 2 years for $42.00; 3 years for $54.00. Add $15.00 per year postage for Canada and all other foreign countries. Submission of articles and photos by our readers is welcome, but we can accept no responsibility for loss or damage to unsolicited editorial contributions.

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Printed in U.S.A.

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P.O. Box 469113, Escondido, CA 92046-9113
or RockAndGem@pcspublink.com

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Spider-web Turquoise

Matrix Makes This Gem More Attractive

Story and Photos by Bob Jones

There are a dozen or so gems that qualify as December's birthstone, but blue turquoise has the longest history of use as a gem of adornment and is high on the major jeweler's birthstone list.

The earliest evidence we have of turquoise being used as a gem predates the birth of Christ by several thousand years. We're not even sure when it was first worn as an ornament; nobody was around to take pictures or make drawings of that early jewelry. The only evidence we have is the bits of blue turquoise we've found incorporated into adornments at ancient grave sites.

The earliest use of turquoise may have been in China. The Chinese have revered stones of all sorts, including jade, chicken-blood stone, and serpentine, and they certainly enjoyed carving turquoise, as well as drilling it to make beads. That practice is still a major art form in China.

If China was not the earliest civilization to use turquoise, perhaps ancient Egypt was, for we have found blue beads among the artifacts in royal tombs. It is even used there as an inlaid gem, contrasting nicely with the bright gold holding it. King Tut's funerary mask contains two different blue gems: turquoise and faience, a blue glass used extensively to simulate turquoise. Yes, even back then they were using gem substitutes! The fact that turquoise is found only in ancient royal tombs tells us it was a valued and highly prized stone devoted exclusively to the royals.

When spider webbing is caused by included quartz, it is often white.

No one knows when the peoples of the Western Hemisphere first began to use the gem. We have found tens of thousands of turquoise beads and other turquoise ornaments in ancient tombs and archeological sites in modern Mexico, Central America, and the Southwestern United States. There is really no way of dating just when such

Spider-web turquoise is frequently associated with Western wear and jewelry.

objects were first used. During the modern mining of turquoise in places such as Aztec Peak at Mineral Park, Arizona, stone implements and leather collecting bags left by the early peoples of the region were found. It was clear that the turquoise was traded for shells from West Coast beaches, but when the turquoise was mined is not clear.

Today, turquoise is what might be called "everybody's gem," for it is so common and popular. At times, its popularity wanes, but it has emerged again and again to take its place in the gem and jewelry markets of the world.

What I find interesting about turquoise is how different people's preferences are concerning this blue gem. Some prefer the natural nuggets, while others want the gem carved or cut and polished. There is definitely a difference in what type of turquoise is considered "the best." In Europe and Asia, people prefer the solid robin's-egg-blue gem. Usually cut en cabochon, it is worn as a ring stone or mounted in a necklace pendant. This preference of what might be called "pure" turquoise stems from its occurrence in Persia (now Iran), where superb blue stones were found.

Here in the Southwest United States, the more popular form of turquoise is not the pure, monochromatic gem with an unbroken span of lovely solid blue. More eagerly sought—and sometimes more highly priced—is a type of turquoise sometimes referred to as "turquoise matrix."

Turquoise matrix is really a misnomer, since it implies the blue stone rests on another mineral, like quartz, or a type of rock, like sandstone. A better and certainly more popular term for this very attractive gem is "spider-web turquoise," a name that reflects the attractive inclusion of a contrasting mineral.

Spider-web turquoise is aptly named. The term best describes the dark, weblike inclusions randomly snaking through the blue turquoise stone. This particular type of turquoise is frequently associated with Western wear; it is mounted in belt buckles, rings, bola ties, and even collar ornaments, all typical Western-type jewelry. The general feeling is that spider-web turquoise is best mounted in silver, not gold. Silver is favored in Western wear, making the two a perfect match.

Solid-blue turquoise was once found abundantly near Maden in what we now call Iran. It occurs there as small nodules and seam fillings in a trychyte breccia in the Mirsah Mountains of the Neyshabur region of Khorsasan province. This deposit is one of the oldest known sources of this lovely gem. The deposit also produced richly patterned spider-web turquoise, but the solid blue gems were more highly regarded.

The host rock here, trychyte, is an extrusive igneous rock that, in this case, was fractured and broken, hence the term breccia. The turquoise was not a part of the original deposition, but was later introduced into the fractures by copper-rich solutions. It solidified in a nearly amorphous form. No crystals have been found here, only massive gem material.

The solid blue Iranian turquoise is often used as the standard for turquoise color in the gem industry. The noncrystalline gem was so highly prized that it was even used in the royal jewels once owned by the Shan of Iran. For a nongemmy, noncrystalline mineral to achieve such recognition is most unusual, since colorful, transparent gems are more often prized by royals.

Another ancient source of solid-blue turquoise was in a region on the Sinai Peninsula, across the Red Sea from mainland Egypt. Just who found this source is unknown, but the Egyptians sent convoys of slaves to work the deposit, located in Wadi Maghara. Here, the turquoise occurs in porphyritic rock, an igenous rock consisting of several partially crystallized minerals like feldspar and quartz. After the original rock formed, solutions invaded this rock, depositing the blue gem in seams and small nodules. Turquoise is a secondary mineral wherever it is found.

Turquoise from these early sources was largely in solid-blue masses. When it did have inclusions, it was considered less valuable. People in Europe and the Near East developed a liking for the homogenous blue gem, unadulterated by inclusions.

In the American Southwest—New Mexico, Arizona, Nevada, and Utah—solid-blue turquoise is also highly prized. Native Americans also considered it a stone from the gods in the heaven. Every Native American strove to own it and use it in jewelry and adornment. Since spider-web turquoise was more common, it gradually became the gem of choice. Each of the Southwestern states boasts many deposits of turquoise, so the gem has been readily available here. The attractive combination of turquoise and an included mineral has gained far more appeal in the Southwest than it ever did overseas. Luckily, turquoise has been so abundant that even we common folk can enjoy its natural beauty.

The contrast between the lovely blue of turquoise and the included matrix gives it added attraction, which strengthened its appeal. Or perhaps the monochromatic blue stones, never abundant, could not satisfy the market. So matrix, or spider-web, turquoise gradually gained in popularity through its eye appeal, the need to meet market demand, and its natural symbiotic relationship with Western wear.

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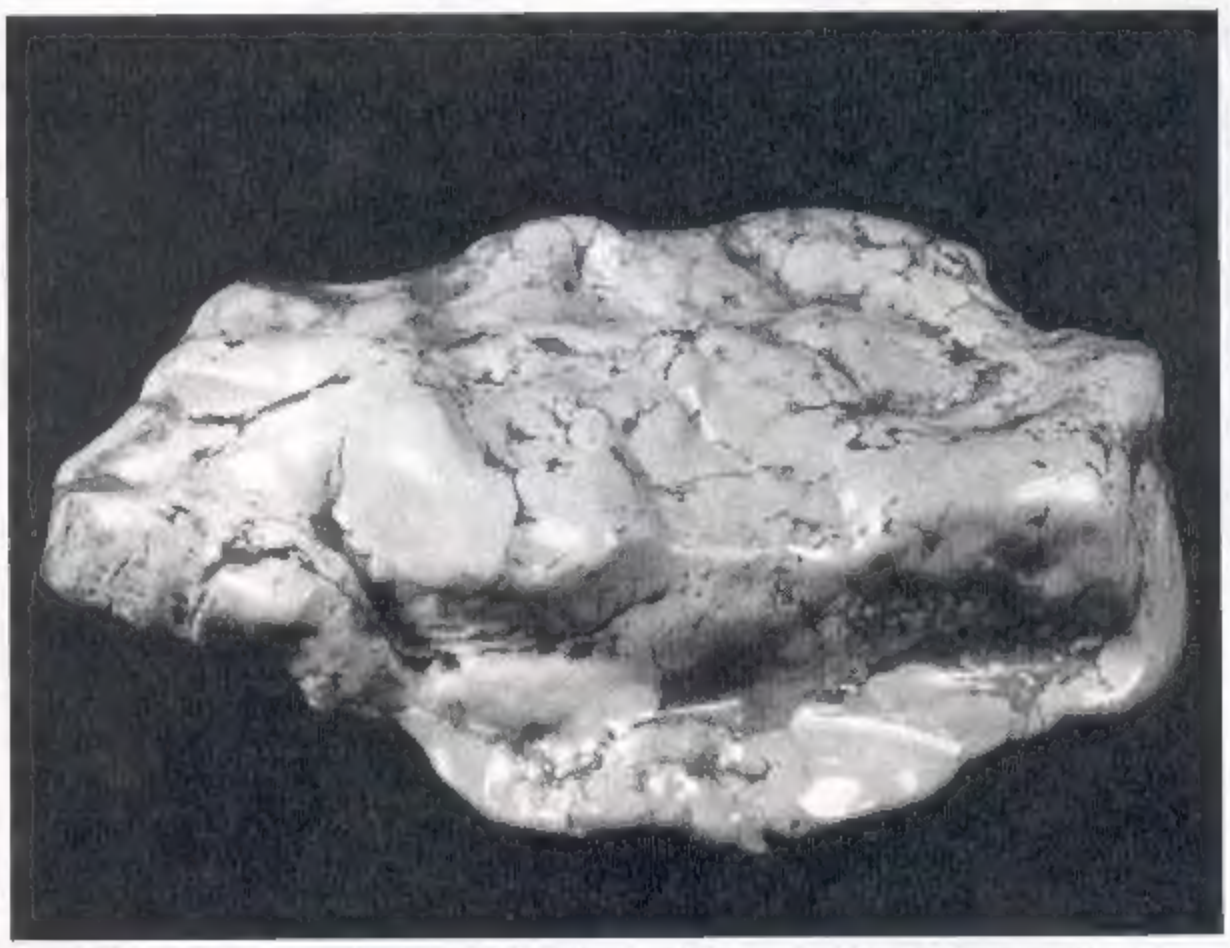
Spider-web Turquoise *from page 13*

Spider-web turquoise gets it name from the thin lines of dark included material that run randomly through the blue gem field. These lines seem to wander aimlessly, creating very attractive contrasting patterns that break up the blue color, which some consider monotonous. These random spider-web patterns seem to be especially popular in stones of large size in which the patterned inclusions show to good advantage.



Red iron oxide makes this otherwise ordinary stabilized turquoise much more attractive.

The turquoise that generally brings the higher prices in Arizona is the spider-web gem blue from the famous copper deposit at Bisbee in Southeastern Arizona. Bisbee consists of two major types of copper deposits. The first to be discovered and worked was the secondary replacement ore in the limestone formations of the Mule Mountains. Later, mining at depth revealed a huge copper porphyritic deposit. This was developed as an important open-pit mine. To do so required the shifting of a local highway along with a few mine buildings.

The Bisbee porphyry deposit, while modestly endowed with copper metal, yielded thin to thick seams and nodules of bright blue turquoise, much of which is delightfully patterned with one of several included minerals in spider-web patterns.

Just what are these mineral spider webs in turquoise and how did they get there? Few if any minerals are found in pure form. Impurities are a given, since the mineral-bearing solution can contain a host of elements and compounds. Even the lovely robin's egg blues of Iran can occur with inclusions. These specimens are either culled out or sold for less money.

Whether turquoise has the spider web effect is determined by where and how the turquoise forms. Porphyry and trychyte have already been mentioned as sources of the gem. Quartzite and pegmatite deposits have also produced turquoise, though rarely when compared to the others mentioned. Sedimentary rocks have also produced turquoise. The blue mineral can form anywhere the required chemical ingredients are available. Of these rock types, the copper porphyries are the more common sources of turquoise. After all, copper has to be present for the gem to even exist.

Since turquoise is a hydrous copper aluminum phosphate, these ingredients must be present in sufficient amounts to develop the gem. The action of weathering releases the necessary ingredients from the surrounding rock. Aluminum is derived from decomposing feldspar, and phosphorous is usually in the form of the phosphate radical, which is composed of phosphorous and oxygen. It is most often derived from the breakdown of the mineral apatite. Luckily, porphyritic rock and all sorts of granitic and igneous rocks contain some form of the mineral apatite as an accessory mineral.

The phosphate radical is exceedingly chemically active, so when it is released, it can combine with copper and aluminum ions to form turquoise. All this happens while these ions are in solution, where they can move and combine. Some of the water in the solution joins in the chemistry to complete the molecules of turquoise.

All this chemistry is happening while the soon-to-be turquoise is in solution. The solution can be carried and deposited anywhere there are openings in the host rock. Sometimes, turquoise forms in thin seams. Other times, the solution fills a small opening and the turquoise forms as a tiny nodule. In rare cases, these nodules can be 4 or 5 inches across. Such masses, however, are low-grade, being softer and a less intense blue.

Solutions are notoriously impure. As weathering works its magic of breaking down existing rocks and minerals, it gathers into itself all sorts of dissolved minerals and elements: feldspar, quartz, manganese oxide, iron oxide, you name it. The host rock may hold minerals other than those that go into the make-up of turquoise. These impurities will ultimately end up in combination with turquoise.

Each mineral has a different temperature of crystallization, at which the liquid changes to solid. Luckily, not all minerals crystallize at the same temperature. Turquoise is a low-temperature secondary mineral, so it remains in solution while the high-temperature minerals crystallize. Quartz and feldspar may also crystallize at fairly low temperatures. It is not unreasonable to assume these minerals can end up crystallizing simultaneously with turquoise, ending up in combination. The silicates form in strands or filaments, as does turquoise. These strands of mineral end up as the spider webbing in the blue gem. Other minerals, iron oxide and manganese oxide, which are more often seen in turquoise, also crystallize at low temperatures. Spider-web turquoise containing colorful oxide minerals is more attractive than that with the feldspar/quartz inclusions, which usually lack color.

Spider-web turquoise may also form when turquoise fractures and is invaded by a mineral-rich solution.

Since various minerals end up included in turquoise, the color or shading of the inclusion can vary. When quartz is the impurity (I prefer to think of it as an enhancing inclusion), spider webbing can be white or virtually colorless. If the quartz contains impurities, it can be reddish, black, gray, and even a mixture within an individual piece.

When an iron oxide is the inclusion, it can be a lovely brown to reddish color. Black spider webbing is usually due to a manganese oxide inclusion, though quartz or feldspar can be shaded by a manganese or a black iron oxide impurity. Since nature seems to enjoy mixing things up, the inclusion effect can vary from locality to locality, and even in stones from the same source.

Currently, Chinese turquoise in nice, large nodules is available. Usually, the

continued on page 16

Spider-web Turquoise *from page 14*

included matrix is black, so it is probably a manganese oxide. Unfortunately, manganese oxide can be rather softer than the turquoise, which is just under Mohs 6 at best. When working a piece of Chinese turquoise with such inclusion, the problem of undercutting rears its ugly head!

The opposite happens when you work with turquoise that has quartz spider webbing, such as that from Aztec Peak, north of Kingman, Arizona. The spider webbing is harder than the turquoise, so you have to be cautious about gouging into the turquoise.

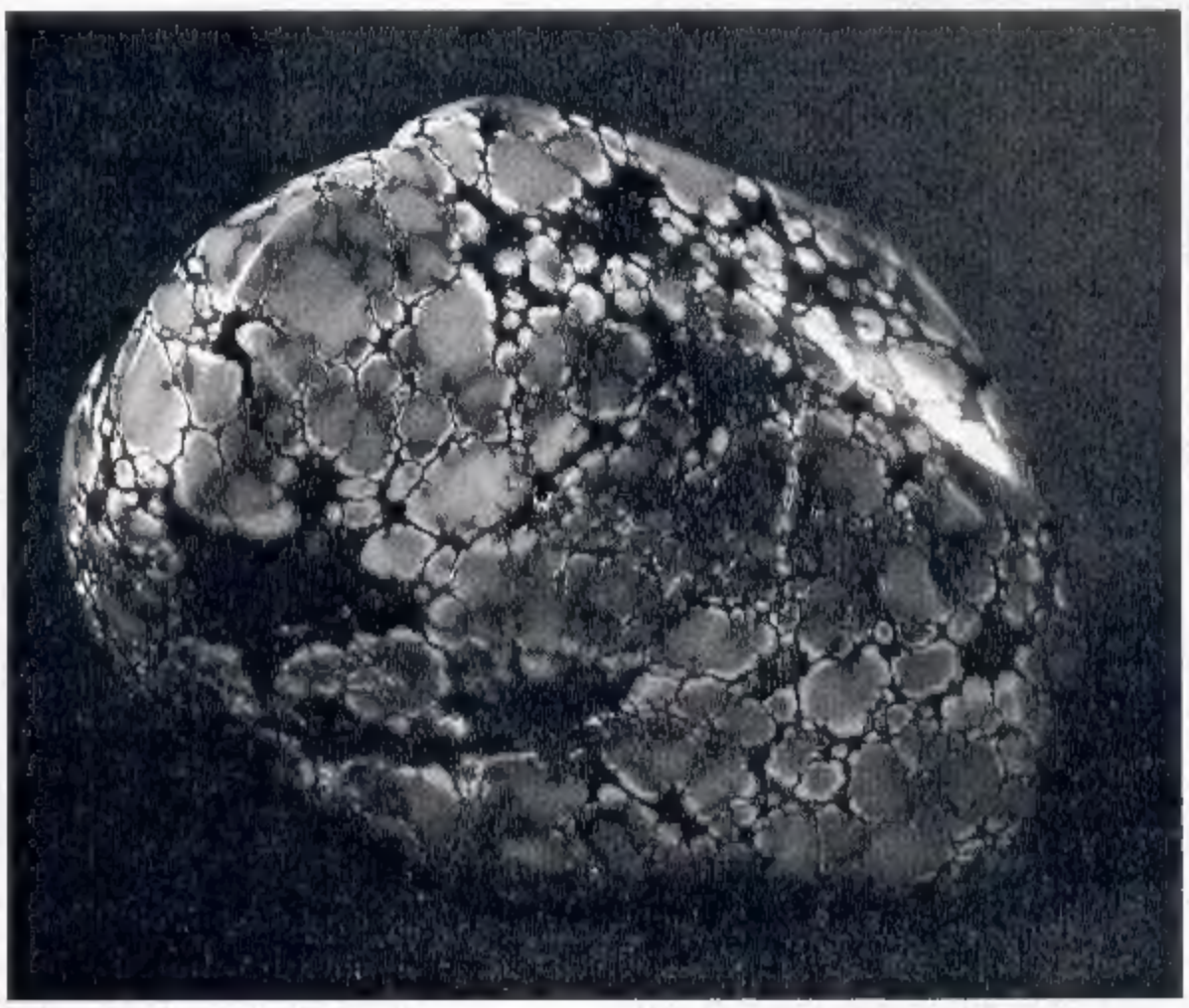
If turquoise forms from a solution deposited in any available opening, why does it not form nice crystals, but only massively? Certainly, a solution that deposits turquoise is rich enough for crystals to form.

It may surprise you to know that turquoise does form in crystals. However, visible crystals have only been found in a couple of places. Though the solid nodules and seam fillings show no visible crystal faces or forms, they are actually composed of submicroscopic crystals; we call this a cryptocrystalline mineral. This is because, as turquoise reaches its temperature of crystallization, it forms so many submicroscopic crystals that they interfere with each other's growth and end up in compact, tightly bonded masses. This compacting makes the mineral less porous, while giving it good hardness. If the turquoise, as it develops, has space to grow larger and larger, it becomes less compact. This makes it more porous and usually a less intense blue.

Turquoise from various localities varies in hardness due to variable crystal growth. The hardest turquoise takes an excellent polish and develops a lovely luster.

The porosity of turquoise, even that which forms in narrow seams, means it can be infused with an acrylic plastic. This material stabilizes and hardens soft turquoise, which has exponentially increased the amount of turquoise available for sale and for use in jewelry. It's a good thing, too, since natural turquoise, always in demand, is costly and not always available.

There is one American deposit that has yielded choice visible, or discrete, crystals. They occur on a schistose matrix in a low-grade copper deposit at Lynch Station, Campbell County, Virginia, that was once operated as the Bishop Mine. Collectors found the dumps of this old mine to be rich in tiny, bright-blue triclinic crystals, which coated the grayish rock. The crystals are never large, just a few millimeters long, but they are proof positive that turquoise can form visible crystals. Unfortunately, the dumps of this old mine are no longer as rich in specimens as they once were.



Chinese spider-web turquoise often has soft manganese oxide as the inclusion.

Years ago, I visited a person—I choose not to call her a collector—who had gone to the Bishop Mine on a club field trip. She later decided she wanted a lot more specimens that she could collect in one day. She actually had some of the dump removed mechanically and taken somewhere else so she could collect all by herself. She showed me hundreds of specimens she had obtained this way. I found that most distasteful and downright greedy!

There have been minor occurrences of turquoise crystals in Belgium and France, but these are insignificant. The Virginia deposit stands as the most significant source of crystallized turquoise. Any spider webbing found in this material results from a member of the arthropod family, not from any included mineral!

The porosity of turquoise, earlier mentioned, has become a most useful property. Even the Native Americans used this to improve marginal stones by rubbing them with bear fat. The turquoise would take on a darker, richer, more lustrous appearance. Ancient gem sellers used to carry turquoise under their armpits, and the moisture in their sweat would give the stone a better color.

The natural porosity of turquoise has been used to our advantage. As the supply of naturally hard turquoise was consumed by craftspeople, demand exceeded supply and treatment of the remaining softer, lighter blue, and more porous turquoise was all that remained. Proper treatment made the turquoise harder and tended to darken its color. Today, treated turquoise is very useful, very attractive, and completely accepted by the gem community—so much so that the cost of treated turquoise, which was quite reasonable, has risen. Many of the earlier-producing sources such as Bisbee have dried up or slowed production, so the supply of turquoise is limited. The recent increase in interest and demand for this blue gem is why treated turquoise is not only accepted, but is far more prevalent than natural stones.

Spider webbing in turquoise is not affected by treatment. It not only retains its color, but is improved. The attractive spider-web patterns are unaffected. In fact, in the case of turquoise with quartz-type inclusions, the addition of the acrylic makes the hardness of the blue stone approach that of the included quartz and minimizes undercutting.

Superb robin's-egg-blue stones with no inclusions are still considered by most as the premier gem, but spider web turquoise is highly prized, especially in the Southwestern United States. So when you select a nice piece of turquoise jewelry, don't be put off by the dark, gracefully curving or geometric patterns of inclusion some turquoise has. Spider web turquoise ranks high in the minds of most westerners!

Shop Talk

William A. Kappele

More Ideas for Boxes

In my ongoing quest for things to do with the fruits of our lapidary efforts besides further adorning Uncle Fred and Aunt Freda with pendants, brooches, buckles and bolas, I have decided to revisit, update and expand the subject of boxes. There are all kinds. They are fun to make and, if nothing else, you can give Uncle Fred and Aunt Freda a couple of them to keep all those buckles and bolas in.

My first column on this subject some years ago was directed primarily toward small, round boxes of wood or ceramic with tops made of round or hexagonal cabs. Some of them were turned on a lathe, and if you are a woodturner as well as a lapidary, this is a natural choice for you.

If you aren't, don't worry. Craft stores are filled with these little boxes, either finished or unfinished. Just buy a few, spray a nice coat of purple gloss enamel on them, whip up some cabs, glue a disk of stone or masonite the size of the box opening to the bottom of the cab, and you've got a few stocking stuffers.

You don't want to overlook the traditional square or rectangular stone boxes, either. These things will test your joint-making ability, but when finished, they can be beautiful. Think also of combining wood and stone. A wood body with a stone lid, or vice versa, gives a completely different look.

A mosaic box is a great way to use those little cutoffs that were too pretty to throw away. There are a number of treatments you can give these bits. They can be glued in a frame, roughly fitted together and grouted. They can be glued in a frame and completely covered with a clear resin, and they can be cut in geometric patterns and tightly fitted. The frames can then be used for boxes or just for lids.

Wooden boxes, either purchased or made by you, can be covered either partially or completely with stone. As in the examples for frames above, the stones can be tightly fitted, loosely fitted and grouted, or covered with resin.

Don't overlook single stones, either. You may have a box that would benefit from a nice gemstone inlay or overlay. I can picture a nice walnut or rosewood box with a beautiful Montana dendritic agate inlaid in the lid. Aunt Freda would bake you a triple-layer chocolate cake for one of those.

Finally, all kids collect rocks, right? If you have small kids, grandkids, neighbor kids, or any kid with a toy box, take their rock collection and figure out a nice placement on the lid of the toy box. Depending on the collection, you might want to outline the lid or create a mosaic on the lid. You might even write the owner's name in rocks. Better yet, why not let the owner of the toy box do the designing? Then all you have to do is get out the silicone or epoxy and start sticking them down.

Please feel free to contact me if you have a suggestion or comment about this or any of my Shop Talk columns. My e-mail is quappelle@cox.net, or write to me at 25231 Pericia Dr., Mission Viejo, CA 92691.

THE FRUGAL COLLECTOR

THE SILICATES

Part IV:
Dioptase, the Spodumenes, and Olivene

Story and Photos by Bob Jones

The silicate group of species is the largest chemical group of minerals and boasts a wide assortment of very colorful species, many of which are very common. One of the more delightful copper silicates that has been found in quantity is dioptase, a richly colored green mineral that forms in trigonal hexagonal crystals seldom as much as an inch long. Its appeal lies in the rich color of the carpet of bright crystals on matrix. The larger crystals reach 2 inches on an edge, but specimens are frequently tightly intergrown masses of sharp prisms.

Not only is dioptase a very spectacular display specimen, but small, flat, crystallized plates of the mineral are sometimes wire wrapped or otherwise mounted for use as a pendant.

When dioptase was initially found in the Ural Mountains, it was confused with emerald because of its color. It has a Mohs hardness of 5 and is a bit soft for jewelry use except in a protective mounting.

Siberian dioptase was long considered a rare species after it was described by René Just Haüy in 1797. Eventually, several other localities, primarily in Africa, began producing huge quantities of the mineral. The African specimens were far showier than the Siberian crystal groups.

Dioptase's vibrant green color makes it a very popular collector mineral. It occurs in copper ore deposits, but only as a minor copper ore. Chrysocolla, another copper silicate, is far more common and forms under broader conditions of crystallization. Therefore, any exposed during mining is saved whenever possible.

The type locality of dioptase is in the Ural Mountains. Altyn-Tyube, Khirgiz Steppes, Qaraghandy basin is now in Kazakhstan. Crystals from here are never large, seldom reaching ¼ inch. They occur as scattered crystals or small crystal clusters in small vugs in a dark-gray to tan limestone.

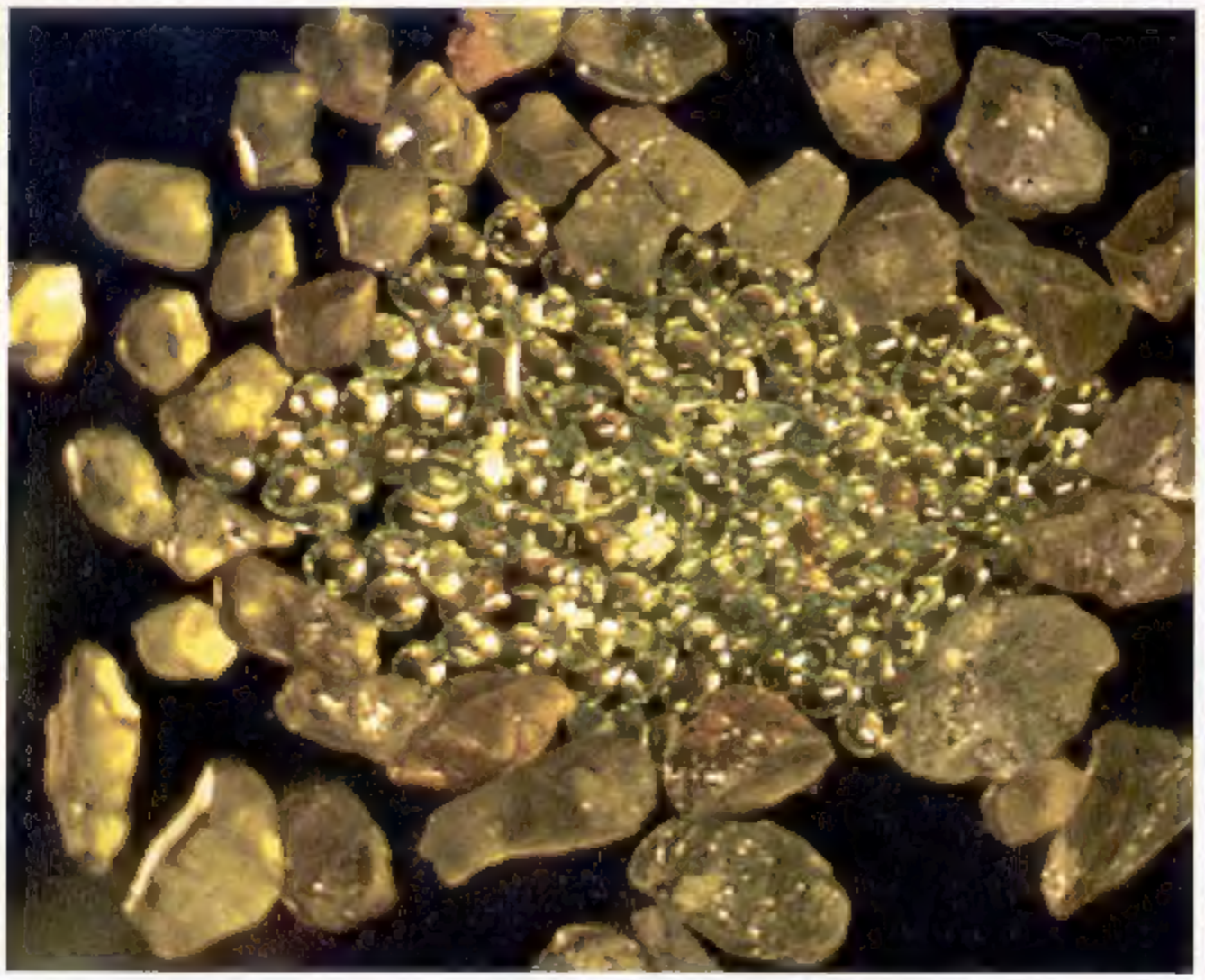
The famous mine at Tiger, Arizona, has produced superb combinations of orange wulfenite, white cerussite, and the green silicate diopside.

In the United States, brilliant emerald-green crystals were found in several Arizona mines that were not necessarily major copper producers. Mammoth-St. Anthony, the famous old gold mine at Tiger, Arizona, produced huge quantities of this lovely mineral, though very little copper. The Tiger crystals are seldom more than a couple of millimeters long, but regularly occur in tight, lustrous, radiating sprays up to a centimeter across, often covering a botryoidal clay layer.

The Tiger dioptase sparkles brightly and provides a colorful background upon which other species occur. It is almost always found with bright-orange wulfenite crystals to ¼ inch perched on the emerald-green crystals. A second frequent associate is white, usually "V"-twinned cerussite, which is the more ubiquitous mineral at Tiger.

Another very popular form of Tiger dioptase is the nearly complete spheres. They are often no more than ¼ inch across, but are very attractive. They are exceptionally dark green with high luster.

The pegmatites in Afghanistan have produced the world's finest kunzintes on matrix.



The San Carlos Apache Indian Reservation, near Globe, Arizona, produces about 90 percent of the world's gem peridot supply.

The dioptase-wulfenite-cerussite combination from Tiger is a classic trio of species that makes a wonderfully attractive collector suite on a single specimen. While the individual dioptase crystals are small, the overall effect of bright, emerald-green dioptase, white cerussite, and orange wulfenite is especially attractive.

One local collector told me he used to be allowed to collect at the mine when it was working. He could stand at the conveyor belt bringing ore up from deep in the earth and collect dozens of specimens of whatever mineral was hit during mining. Though this mine has been closed for years, the quantity of minerals recovered from it was considerable. Specimens are still available today.

Several other Arizona copper deposits have yielded microscopic dioptase crystals that are lustrous and sparkly. The Christmas Mine near Hayden, Arizona, has yielded plenty of specimens of this mineral. The mine is better known for its occurrence of rare kinoite, named for Fr. Kino, a missionary who helped open the southwestern territories.

An old gold mine in the Harquahala Mountains, near Salome, Arizona, produced plenty of dioptase in tiny crystals on chrysocolla. Again, the crystals were microscopic, but in such nice clusters as to constitute attractive display specimens.

Africa is the world's major source of superb large dioptase crystals. As far back as the 19th century, choice dioptase was found at Mindouli. Other Central African deposits were found at Guchab and Reneville. The Guchab specimens were often large with a geodelike form. Bright-green, tightly clustered crystals line the interior curving walls of matrix.

Collecting in Africa before World War II was interesting. One of this country's most active early specimen dealers, Martin Ehrmann, made a trip into the African interior to dig dioptase.

The deposit at Renneville was on tribal land, so Martin contacted the chief of the tribe to obtain permission to collect by employing locals to dig specimens. The tribal chief said he would give permission and provide workers, but only if Martin paved the dirt trail in front of his dwelling! Ehrmann fulfilled the request and got the permission and muscle he needed to dig. The dig proved very successful!

In recent years, the vast development of the Central African copper deposits has proved fruitful. The Mashaba West Mine in the Shaba Province of Zaire has yielded typical, small dioptase crystals, sometimes on pale blue plancheite and chrysocolla.

Of course, the world's premier source of superb collector dioptase is the copper-lead mine at Tsumeb, Namibia. When I was there, the mine had just closed, but you could still obtain specimens from local miners and shops.

I can't even estimate the quantity of dioptase that came from this deep hydrothermal deposit. There was so much at the 1977 Tucson Gem & Mineral Show that I named it "The Year of Dioptase" in my 50-year history of the show. It is impossible to estimate how many specimens were actually collected during that period of mining, since just as many or more flats of dioptase went to Europe as were seen at Tucson.

While dioptase is a typical secondary mineral, at most copper deposits the production of the species ceases when the oxide zone is mine out. Not so at Tusmeb. The normal oxide zone was mined through to the sulfides below, but Tsumeb contained a second rich oxide zone deeper underground. More on this later.

The depth of the oxide zones in ore deposits is determined by weathering and location. The better sources are found in desert regions, where weathering penetrates much more deeply due to a low water table. Here in Arizona, it is not unusual for weathering to reach well over 1,000 feet into the ground. When weathering tears into the primary sulfides and converts the decomposition products into secondary minerals, dioptase is one such mineral.

Before the end of World War I, Namibia was German West Africa and Tsumeb was operated by a German staff. For that reason, much of the dioptase mined in the upper oxide zone in those days went to Europe, where collectors absorbed it easily. In the days before the war, Fred Kagel was the German mine superintendent. His collection eventually ended up in the Smithsonian Institution. A few pieces of his collection may be seen in Dr. Mark Bandy's collection, which was donated to the Los Angeles Museum of Natural History by Jean Bandy after Mark died.

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After Germany lost the war, Namibia became a protectorate under the control of South Africa. Specimen production continued while the upper oxide zone was being exhausted. Secondary minerals, including dioptase, continued to issue forth until the normal oxide zone, later known as the upper oxide zone, was mined out and sulfides became the primary ore.

Normally, this would be the end of oxide mineral production in a mine. However, as we mentioned, a second oxide zone was found here at depth.

The discovery came about because of a major fault that plunged at a steep angle into the earth, cutting across a deeper portion of the primary sulfide ore body. This introduced the necessary water and oxygen to initiate weathering of the sulfides. This, in turn, created a second oxide zone, which proved to be even richer in secondary minerals than the mined out upper oxide zone.

The amount of dioptase mined just prior to the 1977 Tucson Gem & Mineral Show was so great it seemed every dealer had several flats of the green copper silicate. Six years later, another deluge of green dioptase came to the show from Tsumeb. Countless thousands of specimens were quickly bought up.

Much of the dioptase from Tsumeb is in groups of interlocking crystals completely covering the matrix. The crystals are hexagonal and generally very stubby, and seldom occur as free-standing single examples. Much more common are aggregates of small crystals. The largest Tsumeb crystals approach 2 inches, but most common are sharp, dark-green crystals measuring under an inch in the tightly intergrown clusters.

Tsumeb produced so much choice dioptase that it turned an uncommon mineral seldom found in showy clusters into a major collector mineral suited to display.

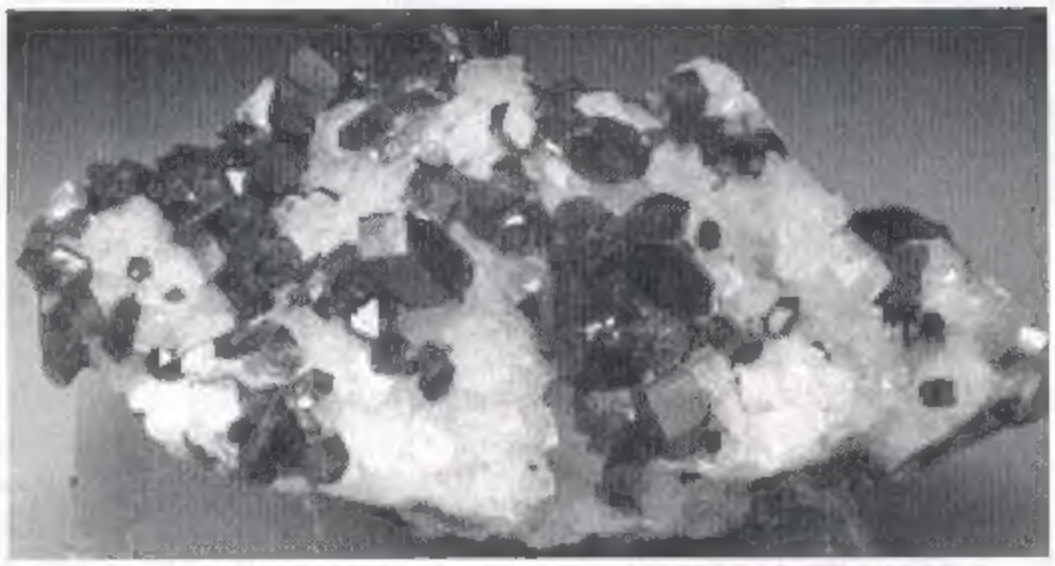
The spodumenes are the most intriguing of the various gem minerals found in complex pegmatites. The group name "spodumene" includes three varieties: triphane, a discredited name; hiddenite; and the more common and very popular kunzite. Spodumenes are a lithium aluminum silicate with trace elements determining which member of the series it is.

This highly prized species was first reported in 1800. Kunzite, the most popular, and hiddenite, the rarest, are the colored varieties of spodumene.

Spodumene forms in monoclinic crystals. The crystals are often lathelike, flat with two broad faces and two narrow faces. Crystals are usually heavily striated and the overall shape—barring severe etching, which is common—is that of a flat, broad sword blade.

Spodumene crystals are usually prismatic, but sometimes stubby. More often, they form exceedingly long blades, up to several feet in length. These very long crystals are never of gem quality, but are a source of lithium ore. Some crystals show twinning.

Of particular interest is the pleochroism of the transparent crystals of kunzite. Three different colors can be seen in the same crystal when it is viewed from three different directions.



The famous specimen mine at Tsumeb, Namibia, has produced the world's finest dioptase.

Aside from the opaque gray to white to tan crystals, which are considered ordinary spodumene, there are three gem varieties: triphane (colorless to yellow), hiddenite (green), and kunzite (violet).

Kunzite is named for George Kunz, leading gemologist in the late 1800s and early 1900s. Triphane, identified in 1800, was named by René Just Haüy in 1801. Haüy is recognized as having played an important role in the birth of the science of crystallography.

Kunz was actually responsible for identifying the first hiddenites when he visited North Carolina at the behest of Thomas Edison. Edison was looking for a place to raise goldenrod, the bane of allergy sufferers. This plant yields a sticky substance, which Edison felt could be used to obtain latex rubber. Instead of goldenrod country, Kunz found slender, green gem crystals, which were eventually named after Hidden, North Carolina, the small village where the crystals were found. At least one older textbook says the town was named for W.E. Hidden of New York, who was involved in the Kunz project.

Triphane, a now-discredited name for the ordinary colorless to yellow variety of spodumene, has been found in considerable quantities in some of the pegmatite deposits in Brazil, Madagascar, and the United States. Since triphane is at best a pale yellow, it is not a popular gemstone. It is popular with fluorescent mineral collectors because it glows a lovely yellow under long-wave ultraviolet. It may also respond with a dull gray or faintly pink response.

The most common form of spodumene is chalky-looking, crude and usually white blades that can reach amazing sizes. Mining at the Etta Mine in South Dakota revealed dull, white spodumene crystals up to 40 feet long embedded in the quarry wall. The partially weathered crystals could not be extracted in complete form and were only good as ore. In fact, the name "spodumene" is from Greek words meaning "burned to ashes" or "ash colored," which aptly described these ugly, crude crystals long before the gem varieties were found.

Kunzite, the very popular violet gem variety of spodumene, has been eagerly collected since it was first found at a small, important pegmatite in Branchville, Connecticut. Because of its location near institutions of learning, Yale being most important, a number of species were first found and identified at this pegmatite deposit.

Branchville is one of the sites I collected at when I was in college. I described the area's fluorescent species as part of my master's thesis titled "Luminescent Minerals of Connecticut."

The initial discovery of kunzite at Branchville was made in 1879. The crystals were not all that exciting; they lacked intense color and were quite small and rather cloudy. Later, superb gem kunzite crystals were found in quantity in the California gem pegmatites. Its lovely pink to violet color, interesting pleochroism, and large, striated crystal form have made it one of the darlings of the suite of pegmatite gem minerals. It is certainly not as common as beryl or tourmaline, but it is definitely very pretty.

Crystals of kunzite show the typical flat, swordlike shape with a tapering termination. They are striated and, when viewed through the flat prism face, are a pale violet. When you look down into the termination, the color of a kunzite is a darker, richer deep violet. When faceting the gem, the cutter does his best to use that rich color to advantage. He orients the "C" axis so that the strongest color is seen when you view the faceted gem through the table. This impressive color is due to a manganese chromophore. Since

the manganese atoms can occur in either a tetrahedral or octahedral structure, the color of kunzite can vary some from violet to pink.

Kunzite has a Mohs hardness between 6.5 and 7.5. Sometimes, the color within a crystal will show more than one tint, shifting from colorless at one end to violet at the other. This is determined by the distribution of manganese in various parts of the structure.

At the Vanderberg Mine and at the Pala Chief Mine in San Diego County, California, kunzite was found in beautiful loose crystals in the clay filling of the pegmatite pockets in which they formed. These rank among the finer gem kunzites found in America.

The California kunzite crystals were not on matrix because they have perfect cleavage and any pocket movement after formation would jar them loose. Most tend to be several inches long, though fine blades to 10 inches have come from the Vandenburg Mine. No matrix specimens are to be seen from the California mines.

The California sources are no longer producing, but other complex pegmatites are still on line. The amazing Madagascar pegmatites at Vatomandry, Anjanabonoina, Maharitra, and Mount Bity have produced fine gemmy kunzites. All are single loose crystals with some crystals twinned.

This island nation is currently experiencing a renaissance in gem mining, largely due to the increased value of pegmatite gem minerals. Madagascar is not a pleasant place to mine minerals, which contributes to the high cost of its specimens.

Today, the main source of superb kunzite is Afghanistan, where pegmatites abound high in the foothills of the Himalaya Mountains. The high region, at about 15,000 feet around Nuristan, came on line in the early 1970s when Russian geologists discovered complex, gem-producing pegmatites. Later investigation and mining here have proved that the Nuristan pegmatites are the source of the finest kunzites ever found!

These gem-bearing pegmatites occur in metamorphic rocks, including intrusive gneiss, marble and schist. The pegmatite veins extend a couple of miles long with gem pockets scattered along the strike. Some of the kunzite crystals are over 3 feet long and are found loose in clay-filled pockets, typical of disrupted pegmatite deposits.

What sets the Afghanistan kunzites apart from all others, aside from their sometimes immense size and superb color, is that it was possible to collect choice specimens with the kunzite still attached to matrix! In some cases, the matrix is also blessed with gemmy beryl, colorful fluorite, and undamaged mica books. This was the first time any quantity of matrix spodumenes, primarily kunzite, was available to collectors and museums.

The color of these superb gems is mostly in the pink to violet range, but yellow, green and even blue kunzites have come to light. In unusual cases, the kunzites show color zoning. Crystals a foot long or longer have been found in quantity. Under long-wave ultraviolet light, many of these crystals respond with a fine bluish-pink color.

The Afghanistan kunzites also show an unusual physical response to ordinary light and heat. This response is a property called "tenebrescence," a reversible darkening and lightening of color. When colorless spodumene is exposed to strong X-rays or gamma rays, the rays induce a violet or pink hue. This color is unstable, so when the crystal is exposed to heat or ordinary sunlight, it loses the induced color. Ordinary violet or pink kunzite crystals can be changed under high radiation, which turns a pink crystal green. Heat the crystal, and it returns to its original color.

The Afghan spodumenes are either green or blue-violet when they are mined. Recognizing that these are not as appealing as fine violet kunzite, the miners have discovered that boiling the crystals in water, then exposing them to sunlight for a period of time will develop the violet color in the crystals. This color is not permanent. Yet, as long as the crystal is not subjected to extremes of heat or radiation, it will hold the color for a long time. Keep in mind that these crystals are found at very high altitudes, where the atmosphere does not filter out much of the normal long wave U.V. radiation from the sun. This undoubtedly affects kunzite's color once mined.

Spodumene's color varieties are due to different transitional metal ions in the structure as minor impurities. Emerald-green hiddenite owes its color to ions of chromium or, in some cases, vanadium. Paler green spodumene, which is not hiddenite, owes its color to the interaction of the metal elements manganese and iron.

Hiddenite is found as small, slender crystals that almost never reach 2 inches, though a few exceed that. They can be colorless to green with both hues possible in the same crystal. Crystals are usually heavily striated, as well.

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In recent years, some serious digging in the Hiddenite area by Ledford Minerals, a southeastern dealership, has brought to light some of the finest crystals found in recent decades. Collectors should keep in mind that known productive properties in the Hiddenite area are claimed and are off limits to collecting, except where fee digging is offered.

Another North Carolina deposit, a huge pegmatite known as the Foote Mine at King's Mountain, has produced a small number of fine kunzite crystals. The deposit is much better known for choice and rare phosphate minerals and for the feldspar ore once mined there for use as an abrasive and in pottery making.

Other than the California deposits, the major source of kunzite before the discoveries in Afghanistan was several pegmatites in the state of Minas Gerais, Brazil.

Spodumene from Brazil is never common in spite of the plethora of pegmatite deposits that have been worked there. Some very fine, small triphane crystals have occasionally come to light. These fluoresce beautifully under long-wave UV light.

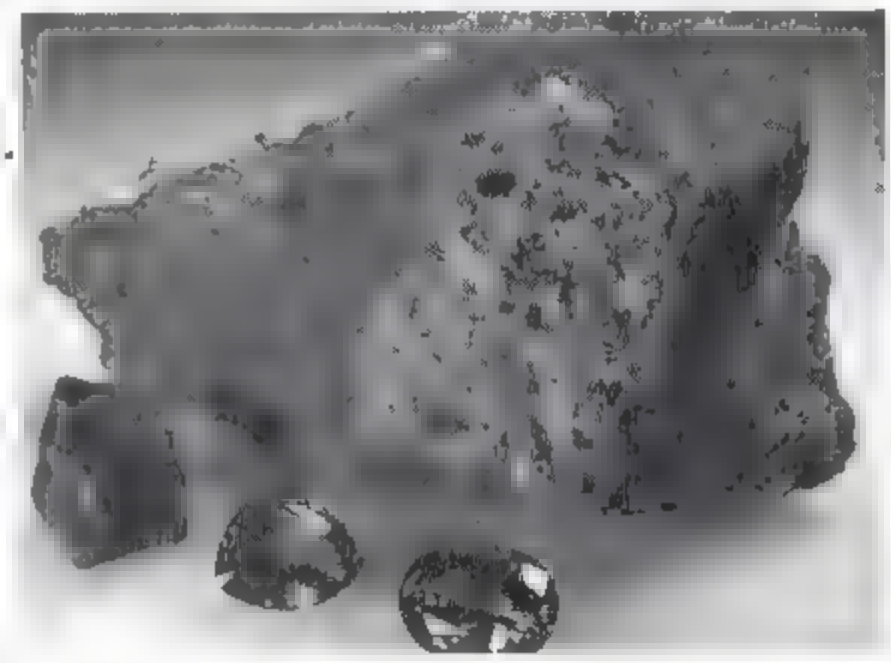
The more important kunzites are found at the Urucuca Mine in Itamboeum and the Urucum Mine in Gabilera. The former deposit produced gemmy kunzites of excellent size, some weighing as much as 15 pounds. The Urucum deposit yielded equally fine, though somewhat smaller crystals. Virtually all the Brazil specimens were found loose.

For several years, the crystals mined in Afghanistan were backpacked over 300 miles to Pakistan, where they could be sold. There are virtually no roads there and the region is not exactly trouble free. These conditions, along with the natural rarity of fine, gemmy spodumene, make the Afghanistan specimens desirable and costly.

There can be a lot of confusion over the mineral term "olivine" and the mineral "olivenite." First of all, olivenite is an arsenate, so it does not belong in this discussion. Yet, it is easy to confuse it in name with olivine, which can be a rock, a gem or two different minerals!

Olivine is really a group, not a mineral, name. If iron dominates in this iron, magnesium silicate, we call it forsterite. If manganese prevails, it is called fayalite. Since we cannot determine the dominant mineral by sight, we simply use the term olivine. Gemmy material is often called peridot or chrysolite because of its green color. We also apply the name olivine to a rock made up mainly of the mineral olivine. So we have two minerals, fayalite and forsterite, and we use the term olivine when talking about either of them or any rock rich in one or both of them!

Olivine is found mainly in ultra-basic or basic igneous rock. One especially important olivine-bearing rock is peridotite, which you immediately recognize as the source of most diamonds. It may also interest you to know that olivine grains were found in some of the rocks brought back from the moon, though I doubt anyone will consider the moon a potential collecting site.



Peridot is found as gemmy, granular material in some basalts. The gems weigh between 5 and 10 carats.

Here on Earth, olivine may also occur as tiny grains in rock or as accumulated grains forming an "eye" in rock. You can also find it as small yellow-green to green eyes in some meteorites. The grains found in basic rocks are usually gemmy and small, but still facetable. These grains seldom yield stones much over a carat in weight. We use the term olivine rather than try to distinguish whether the material is fayalite or forsterite, but if the olivine is gemmy, we call it peridot.

Peridot is a gemstone that has been around for centuries but has always been rare. It was first found on an island in the Red Sea. With just one significant source, it was never common enough to be extremely popular because royalty and the wealthy consumed the limited supply. The Red Sea source, an obscure island, became "lost" during the Middle Ages and was rediscovered in the early 1900s by an English explorer.

Other sources produce small, gemmy grains of peridot that usually cut no more than 2-carat to 5-carat stones. A new find in Pakistan, however, produces peridots that cut in the range of 300 carats. These are really exceptional for the species.

The chemistry of the olivine group creates a series from forsterite, a magnesium silicate, to fayalite, an iron silicate. These two minerals form as a series because magnesium and iron can substitute for each other in the structure. This results in an intermediate species, magnesium, iron silicate, which we sometimes call olivine, but when gemmy, it is the beautiful, glassy, green stone peridot.

A third related mineral name should be mentioned here. In 1952, scientists decided that olivine showing a tan to brown color should be distinguished from peridot and fayalite. Since these brown gem crystals were found on the island of Sri Lanka (formerly Ceylon), the mineral was given the name sinhalite from the Sanskrit name for the island. Later studies showed this was a mistake, so the name sinhalite has since been discontinued, though you'll run across it in the literature still.

Historically, peridot was known and admired throughout early history, especially among the Greeks and Romans. Rumor has it that the lens through which Nero watched Rome burn was of peridot. Some think the green stone in Aaron's breastplate was actually a peridot.

The one important ancient source for gem peridot, already mentioned, produced stones large enough to supply facetable stones. The Red Sea island was originally called Topazios, as the green gems were originally called topaz.

The island later became known as St. John's Island and is now called Zebirget. Fine, green, gemmy crystals to 2 and 3 inches long were found here. They were formed in metamorphosed peridotite that had altered to serpentine. No diamonds have ever been reported here, though peridotite is the host rock for Africa's diamonds.

Plenty of other locations, including New Mexico and Arizona, produce peridot, but only as small grains in volcanic rock and in limited amounts. Maybe the most intriguing of these is Ross Island in Antarctica. One seldom hears of any minerals being found in that vast desert land of ice and snow. I call it a desert because the actual annual rainfall at the South Pole—all of which falls as snow, of course—is less than a half-inch per year.

Another odd source for this green gem is anthills in the Four Corners area of Arizona, Colorado, New Mexico, and Utah. One usually does not associate volcanism with this high, dry plateau country of red sandstone buttes and mesas, but think of Shiprock, New Mexico. This is just one of the artistically shaped volcanic plugs that dot the entire landscape.

in the Four Corners area. Where there is volcanism, there is olivine. There is also pyrope garnet.

These two colorful, gemmy minerals are found as small, rounded grains on some anthills, accidentally "mined" by the ants as they burrow into the ground. Seeking peridot and pyrope garnet in anthills is also a prospecting technique in Africa because these two gemmy minerals are frequently associated with diamond-bearing peridotite pipes. They resist weathering, so they remain for long periods of time once brought to the surface. Ants and termites bring mineral evidence to the surface, and this gives prospectors clues as to what may be below. These grains are too small for any serious gem cutting.

There are other gem-producing areas for peridot. The Mogok District, on Kyatkpon Mountain in Burma (now Myanmar), is best known for ruby production, but an occasional cutting-grade peridot surfaces here.

The San Carlos Indian Reservation in Arizona is a major source of this green gem. At the deposit, called Peridot Mesa, peridot occurs in vesicular volcanic rock. The miners break open the rock, revealing gas pockets often filled with granular, gemmy peridot. The individual grains, when large enough, are faceted. On rare occasions, a grain is large enough to yield a 10- or 15-carat gem. The Smithsonian boasts a rare 35-carat San Carlos peridot, certainly one of the larger peridots found in America.

Most peridot gems were very small until the early 1990s, when an amazing find was made in Pakistan: huge, gemmy peridot crystals in pockets and veins in a shear zone in partially weathered and serpentinized volcanic rock called dunite. The crystals are sometimes 3 inches long and an inch or so thick, all gemmy, and a fine grass-green color. Because of the generous size of these crystals, large faceted stones are possible, the largest cut stone reported weighs 315 carats. Smaller stones — still much larger than the usual finds from Arizona or elsewhere — are now available in considerable quantities.

The Pakistan locality is near Sapat Nala (Sapat Valley, Mansehra District, North West Frontier Province). Remarkable, perfect crystals of fine color, many still on matrix, have been coming from here. Hundreds of thousands of carats of gem peridot have been mined from the deposit some 15,000 feet above sea level. One has to wonder what marvels may still be hidden under the snow and ice of those high and inhospitable mountains of southern Asia.

Gypsy Mine Vivianites

Brazil's Pegmatites Produce Wonderful Specimens

Story and Photos by Bob Farrar

Minas Gerais, Brazil. To a rockhound, perhaps no other place is more evocative of spectacular gems and minerals. It would seem easier to list the minerals that are not found there than those that are. This is not quite true, of course, but the stream of new finds in Minas Gerais does seem endless.

Mining has gone on in Minas Gerais for hundreds of years, beginning with the gold rush of the 1600s. Later, the mining industry began to focus on iron ore and other industrial minerals, gemstones, and collectible crystals. One might think they must have found everything there is to find there by now. However, as I have learned over several years of traveling to Minas Gerais, this is not true by any stretch. Significant new finds continue to be made today, and will likely continue for years to come.

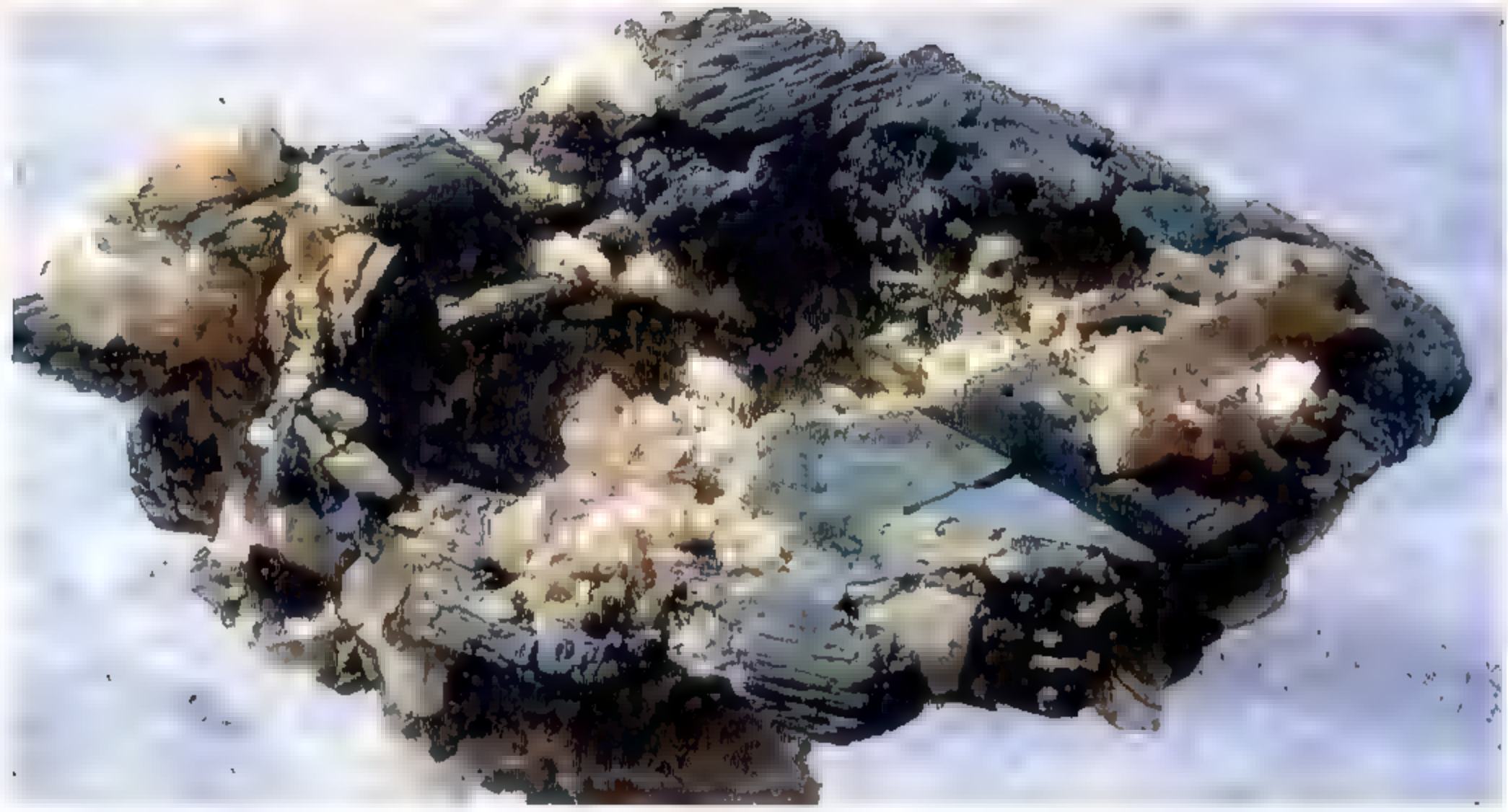
Many of these new finds are made at old localities. Much of the gem and crystal mining in Minas Gerais is done by *garimpeiros* or independent prospectors. It is common for these people to work a site until they either find something or run out of money. The site may then be abandoned, only to be taken over by someone else. Often, important finds are made by these later operators.

For example, there is the story of the discovery of a 244-pound gem-quality aquamarine crystal near Maramba, Minas Gerais, in 1910. It is said that the *garimpeiro* who found it did so after digging only 3 feet in a pit that had been abandoned as worthless.

Lit from behind, this vivianite crystal from the Cigana Mine shows its beautiful green color.

I wrote of one such significant new find at an old locality in the August 2005 issue of *Rock & Gem*. The Navegadora Mine, near Conselheiro Pena, Minas Gerais, had first been worked over 100 years ago, but it was not until 2002 that its first big vug of spessartine was found. I visited the Navegadora Mine in 2004 through the efforts of tour leader Sara Mount. Sara's connections in Brazil led us to Sr. Rogerio Zocoloto, owner of that mine. Rogerio is proud of his accomplishments at the Navegadora Mine and was eager to show off the mine and the great material he had found there. We spent the better part of a day visiting Rogerio at his home in Galiléia and touring the mine.

It turns out that the Navegadora Mine is not the only mine Rogerio operates. He also operates the Cigana Mine, near Galiléia, which produces vivianite, among other things. We had intended to also visit the Cigana Mine that day, but there was so much to see at the Navegadora Mine that we simply ran out of time. Sara and the rest of us on



Vivianite from the Cigana Mine is often intergrown with quartz and muscovite.

that trip knew that if we were ever back in the area again, we would have to get Rogerio to show us the Cigana Mine. That chance came in August 2005.

Cigana is the Portuguese word for "gypsy." A number of years ago, the Cigana Mine was worked by a *garimpeiro* who never stayed in one place for very long and became known as the *cigana*. The name was then transferred to the mine and it has stuck. The mine was first explored about 30 years ago. Rogerio has been operating it for the last 11 years.

The Cigana Mine is located about eight miles from the town of Galiléia, which lies about 30 miles southeast of the city of Governador Valadares. Getting to Galiléia is not difficult. In visiting Minas Gerais, we have always flown into Belo Horizonte, a city of about 5 million people and the state capital of Minas Gerais. From Belo Horizonte, it is about a six-hour road trip to Governador Valadares. The road is paved and is pretty good in most sections. Governador Valadares lies along the main route from Rio de Janeiro to Salvador, a large city on the Atlantic Ocean. This route takes a lot of truck traffic, which tends to damage the pavement. The last time I was there, they were repaving several spots. The road to Galiléia is also paved, and follows the Rio Doce (Sweet River), the largest river in the area. Reaching the Cigana Mine itself requires negotiating a couple of miles of dirt road — no need to hike or ride mules, though.

Galiléia and the Cigana Mine lie within one of the richest gem-bearing pegmatite districts in the world. This area is famous for the many fine tourmalines, beryls, garnets, spodumenes, and other gems that have been found there. Many of the interesting minerals and gems of the Galiléia area, and Minas Gerais in general, occur in granitic pegmatites. The main components of a granitic pegmatite are typically quartz, feldspar and mica. In some pegmatites, that is about all that is found. Many of the pegmatites of Minas Gerais, however, are rich in rarer elements such as phosphorus, lithium, boron, uranium and beryllium. It is from these components that many of the more interesting and valuable pegmatite minerals formed.

The development of the various minerals varies tremendously from one pegmatite body to another in Minas Gerais. At the Navegadora Mine, for example, spessartine crystals are numerous and well developed. At the Cigana Mine, which is only a few miles away, vivianite and other minerals are of the most interest. Even within the same pegmatite body, different minerals will often form in different zones. The result is the great diversity of gems and minerals found in Minas Gerais today.

Of particular interest to mineral collectors are the phosphate minerals that occur in many of the pegmatites in the Galiléia area. At the Sapucaia Mine, for example, more than 40 phosphate minerals have been identified. Among the more familiar phosphates found in pegmatites are fluorapatite, autunite, monazite and vivianite. In the formation of a pegmatite, some phosphate minerals, such as triphylite, are considered primary minerals in that they crystallized when the pegmatite was initially formed. Many others are considered secondary minerals in that they were formed by alteration or weathering of primary phosphates.

Vivianite is one of the more common phosphate minerals. It is composed of hydrous iron phosphate, $Fe_3(PO_4)_2C_8H_8O$ (C_8H_8O denotes that for every two iron ions and phosphate groups, the crystal has eight molecules of water bound to it.) The color of vivianite is typically a deep blue-green, but ranges from nearly colorless to green, blue and violet. It crystallizes in the monoclinic system with a well-developed micaceous cleavage. Vivianite has well-developed gliding planes in which the atoms can move a certain distance without the crystal breaking. As a result, the crystals are often bent.

Crystals that are well developed and transparent with good color can be quite spectacular and are popular with collectors. Vivianite is a very fragile mineral, however, with its micaceous cleavage and a hardness of Mohs 1.5 to 2, so care must be taken in collecting, transporting and displaying it. Vivianite from some localities also tends to lose water and crack.

At the Cigana Mine, vivianite crystals are found in vugs, or *caldeirões* (caldrons), as the Brazilians call them. There they occur intergrown with small muscovite and quartz crystals. The vivianite crystals range in size from a few millimeters to over 3 inches, and

continued on next page

Gypsy Mine Vivianites *from page 29*

Rogerio chiseled out some vivianites as we looked on.

may be blocky in form or more flattened. This is small compared to some vivianite crystals found in sedimentary deposits, such as those from Cameroon, which can be measured in feet. However, for a pegmatite, they are particularly well developed. Vivianite is common in phosphate bearing pegmatites. However, it usually occurs as films, crusts, or very tiny crystals. The Cigana Mine vivianites are exceptional for pegmatite specimens.

The Cigana Mine initially gained fame for aquamarine. Literally tons of aquamarine were taken from the upper zones. As I mentioned, the zones within a pegmatite can vary tremendously in their mineral composition. In the lower areas, where the vivianites are found, spodumene is a predominant mineral. It occurs as yellowish crystals several inches across and several feet long.

Recently, small crystals of fairfieldite (another phosphate mineral) on albite have been found. Brilliant, clear quartz crystals occur in many of the pockets. The mica and quartz in the pockets may be sprinkled with tiny pyrite crystals. Other minerals found at the Cigana Mine include tripaylite, schorl and columbite-tantalite.

We got our chance to see the Cigana Mine late one afternoon. We arrived at Rogerio's house in Galiléia with Sara's Brazilian guide, Harold Widner, and gem and mineral dealer Jan "Johnny America" Vleek of Governador Valadares. It was not far from the house to the mine.

The Cigana Mine is an open-pit operation. I was struck by how narrow it is for its depth. It is perhaps 100 feet deep, but only a couple hundred feet across. Near the surface, the formations are weathered and material is loose, so landslides are a problem, as is runoff during the rainy season.

Rogerio arrived shortly after we did, and greeted us in his usual friendly manner, eager to show us the Cigana Mine. The mine road spirals down into the pit at a very steep angle. It was an easy walk into the pit, however.

A number of different minerals were clearly visible in the bottom of the pit. In several spots, remnants of vugs with bits of vivianite left in them were visible. Most of these pockets were small, measurable in inches, unlike the huge vugs of the Navegadora Mine, which were measured in yards.

Also visible in the vugs were quartz, muscovite, and tiny pyrite crystals. Yellowish spodumene crystals could be seen embedded in the pegmatite. These crystals were large, but were not gem quality. We could also see schorl, columbite-tantalite and triphylite. Rogerio and Johnny picked around at some of the vivianite, while the rest of us picked up a few bits of minerals that were lying loose.

Rogerio then showed us the area he was planning to go into next. He picked up a big pry bar and banged it against a ledge. It made a hollow sound. Rogerio said that he was expecting to find more pockets of vivianite and quartz. His real hope, though, is to hit kunzite, the pink gemstone variety of spodumene. There is certainly plenty of spodumene in the formations at the Cigana Mine. Rogerio could only hope that, as he moves into new zones within the formation, he will encounter kunzite.

We could have spent hours at the Cigana Mine, but the sun was setting and we soon began to lose light. It was time to head back to Rogerio's house in Galiléia and have a look at some of his prized pieces. He had a fabulous collection of vivianite and quartz from the Cigana Mine and spessartine from the Navegadora Mine. There were none of the fairfieldites, though; these may have already been sold.

Lit from the back, some of the vivianite crystals showed the most intense green color I have ever seen in vivianite. Sparkling quartz, sharp muscovite, and a dusting of tiny pyrite crystals added to the aesthetic appeal of many of the specimens.

It was soon time to hit the road again, as we were headed for the town of Teofilo Otoni for its annual gem and mineral show. We bade Rogerio a fond farewell. As we stood in his driveway, enjoying a spectacular view of the Southern Cross, I could not help but wonder what would be the next fabulous new find at an old locality in Minas Gerais. ❖

GOLD AND GEM HIGHWAYS

ROADSIDE PANNING SITES IN NEVADA

Part III: Nye, Pershing, Washoe, and White Pine Counties

Story and Maps
by David and Clois Walker

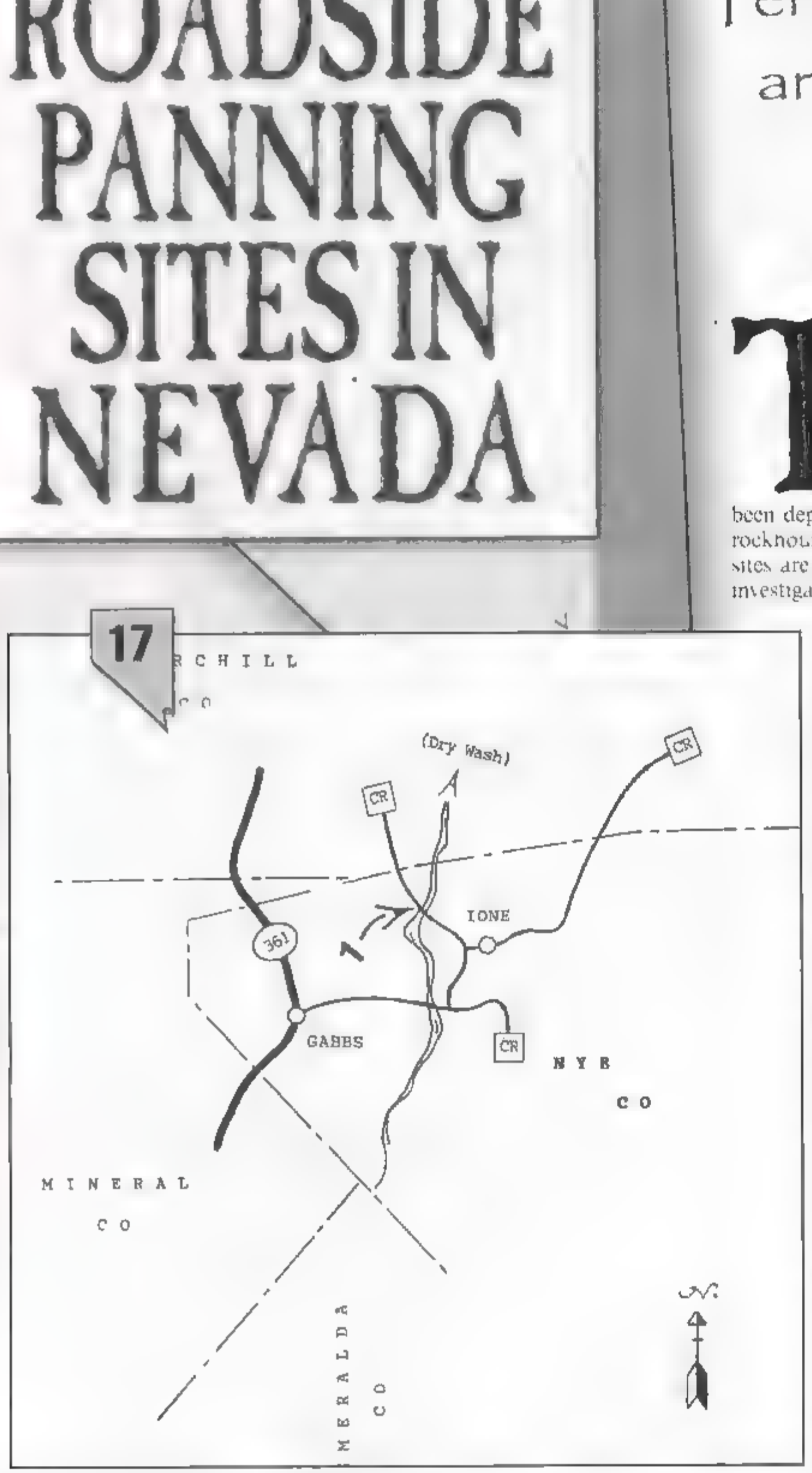
This is the third in a series of three articles containing maps that indicate suggested panning and screening sites at Nevada highway/stream crossings where appreciable finds have been previously reported in vicinity watersheds. The principles of erosion make it likely that minerals and gemstones have been deposited in river gravels, awaiting removal by a rockhound with a pan. Whether conditions at these sites are conducive to panning activities has not been investigated.

By confining operations within government-purchased highway rights of way, panners are spared the necessity of locating and obtaining permission from adjoining property owners, including state and national parks and Indian reservations. However, readers run the risk of prosecution if they cross onto private land whether purposely or inadvertently. In instances where rights of way have merely been leased, other rules may apply.

Nevada welcomes tourists, but requires permits for panning: a separate permit for each of three state maintenance districts. Obtain encroachment permits and safety guidelines for panning in Nevada rights of way by calling (702) 385-6509 (District I office), (775) 834-8330 (District II office), or (775) 777-2715 (District III office), or complete and return the Application and Permit for Occupancy of NDOT Right of Way .pdf form found at www.nevadadot.com/business/forms. To determine which district to contact, download the NDOT Maintenance Districts map from www.nevadadot.com/traveler/maps/statemaps/. Permits must be obtained *before* you visit these sites.

Remember that the government to which these rights of way belong has some regulations of its own. Observe highway safety and environmental standards, such as parking only where designated, and using only a pan and scoop.

The maps provided contain the most up-to-date information available to us, but it is advisable to consult a current state highway or county map when planning an outing, for overall orientation in the field and because highway designations have been known to change.



NYE COUNTY (MAP NV17)

Site 1. **Dry Wash/County Road** crossing near **Gabbs.** Vicinity finds indicate gold potential.

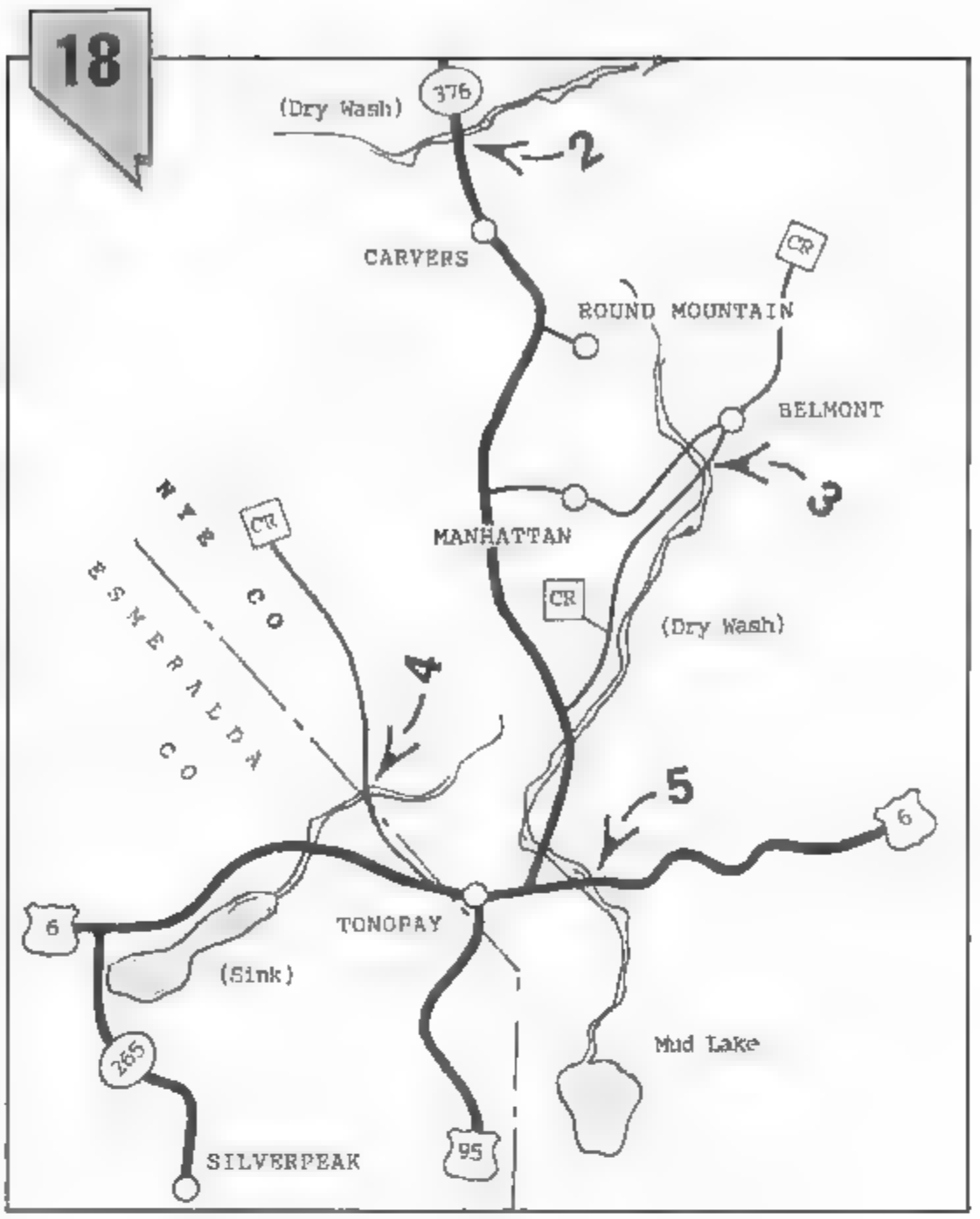
NYE COUNTY (MAP NV18)

Site 2 **Dry Wash/state Route 376** crossing near **Carvers.** Vicinity finds include gold and platinum

Site 3 **Dry Wash/County Road** crossing near **Belmont.** Vicinity finds indicate gold potential

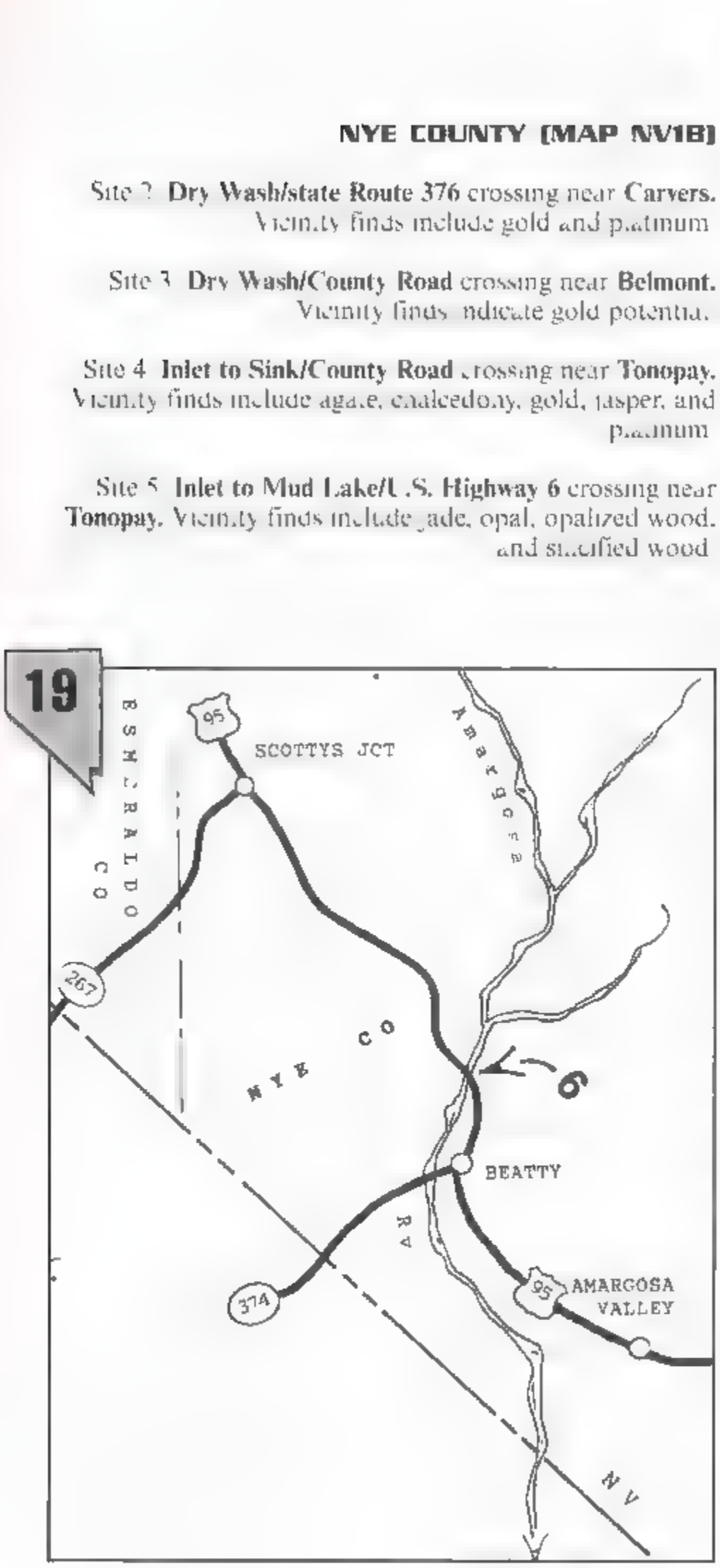
Site 4 **Inlet to Sink/County Road** crossing near **Tonopay.** Vicinity finds include agate, chalcedony, gold, jasper, and platinum

Site 5 **Inlet to Mud Lake/U.S. Highway 6** crossing near **Tonopay.** Vicinity finds include jade, opal, opalized wood, and silicified wood



NYE COUNTY (MAP NV19)

Site 6 **Amargosa River/U.S. Highway 95** crossing near **Beatty.** Vicinity finds include gold, platinum and silver



PERSHING COUNTY (MAP NV20)

Site 1 **Dry Wash/County Road** crossing near **Gerlach.** Vicinity finds include gold, opalized wood, and silicified wood

Site 2 **Dry Wash/County Road** crossing near **Gerlach.** Vicinity finds include gold, quartz and silicified wood.

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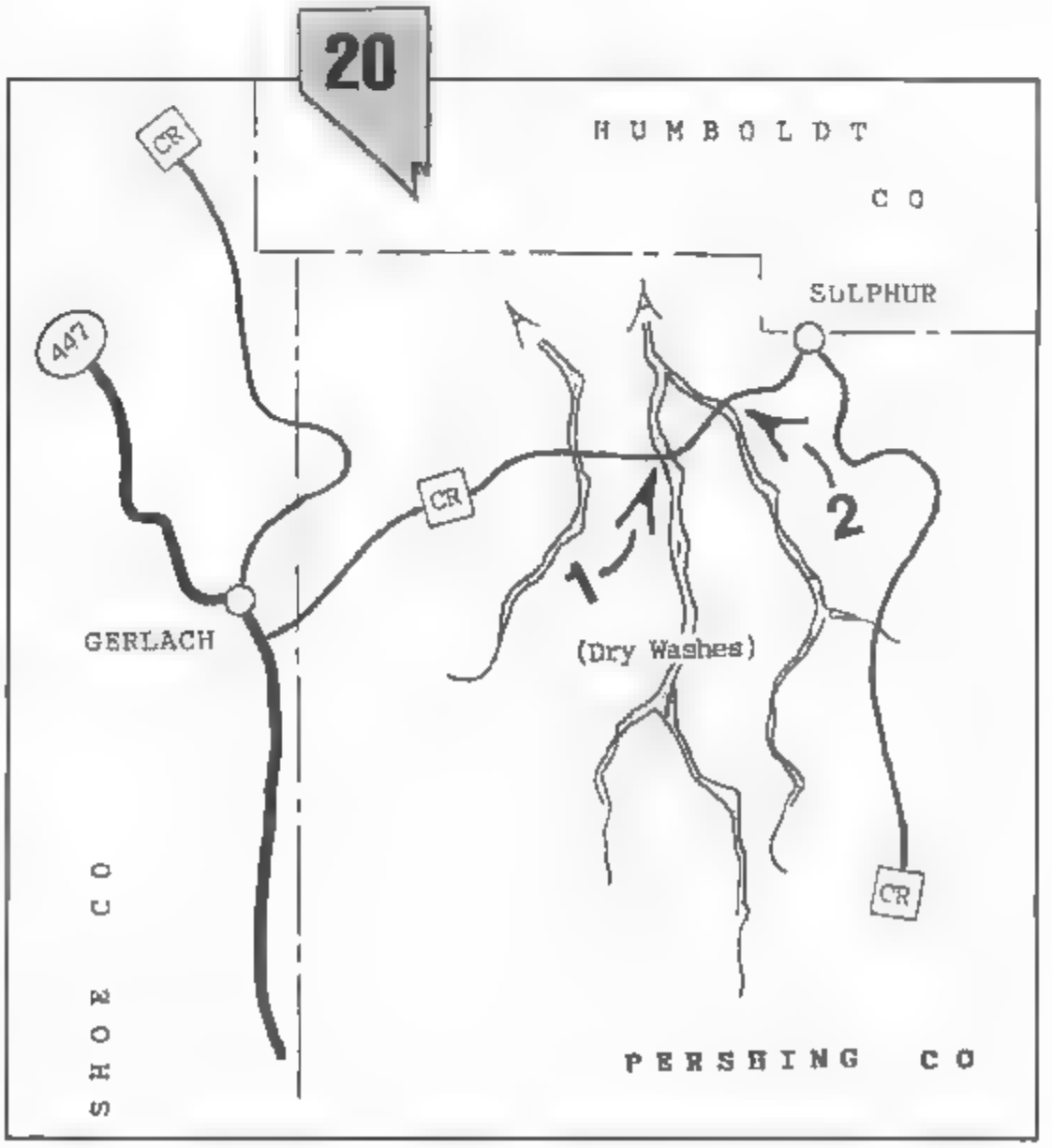
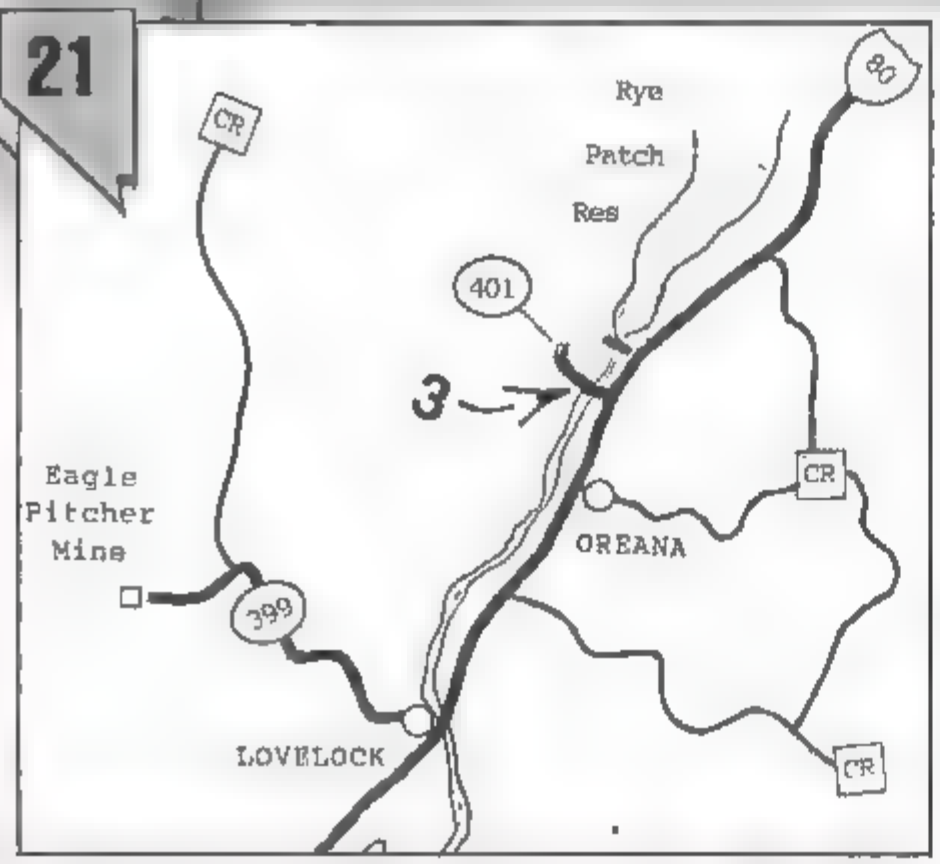
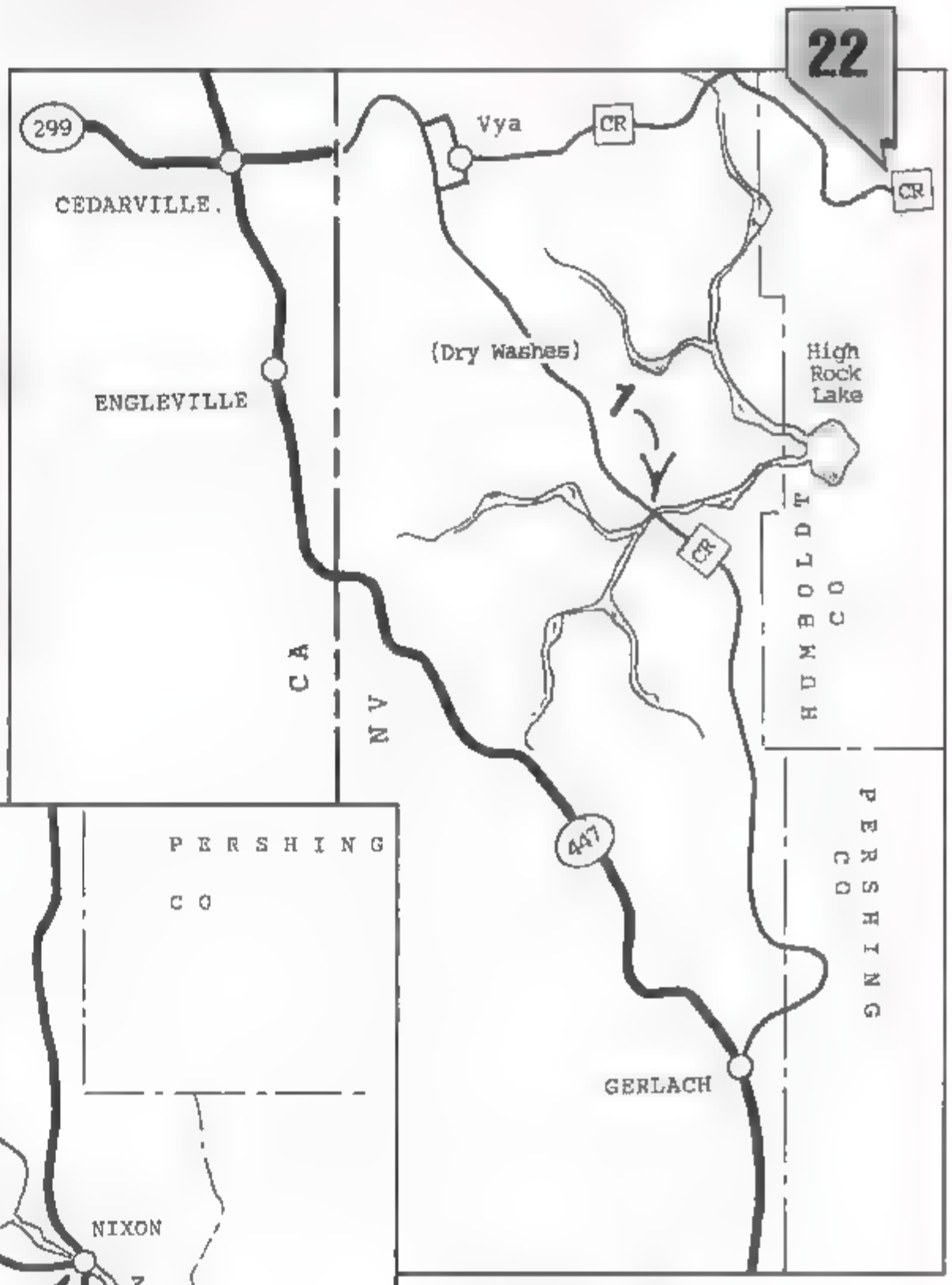




PERSHING COUNTY (MAP NV21)

Site 3 **Outlet Rye Patch Reservoir/state Route 401** crossing near **Oreana.** Vicinity finds include emerald, gold, platinum, and silver.



WASHOE COUNTY (MAP NV22)

Site 1 **Tributary High Rock Lake/County Road** crossing near **Gerlach.** Vicinity finds include garnet and opal.

WASHOE COUNTY (MAP NV23)

Site 2 **Truckee River/U.S. Highway 395** crossing near **Reno.** Vicinity finds include agate, garnet, gold, malachite, obsidian, platinum, silver, and turquoise

Site 3 **Truckee River/state Route 447** crossing near **Nixon.** Vicinity finds include gold, platinum, and silver.

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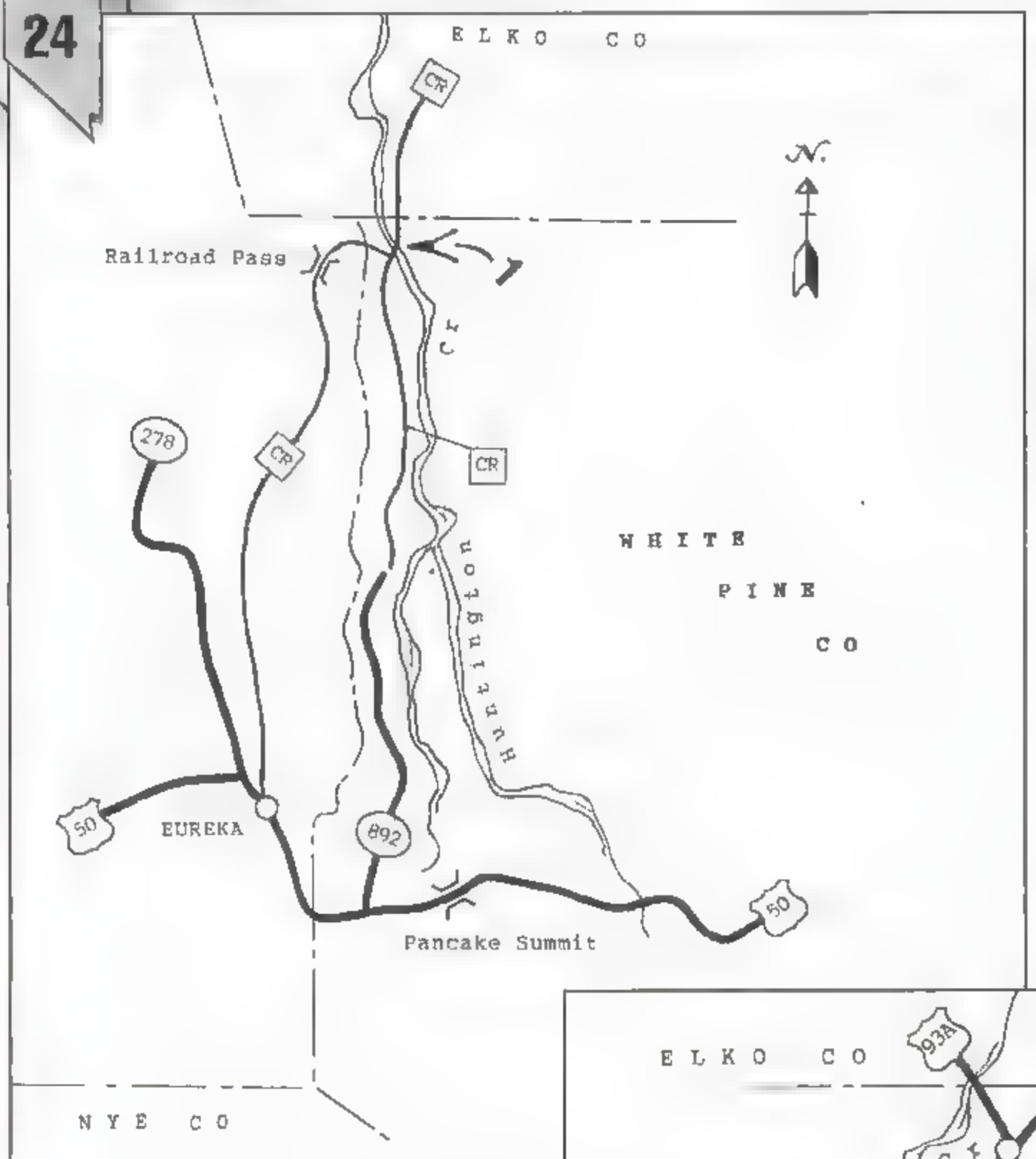
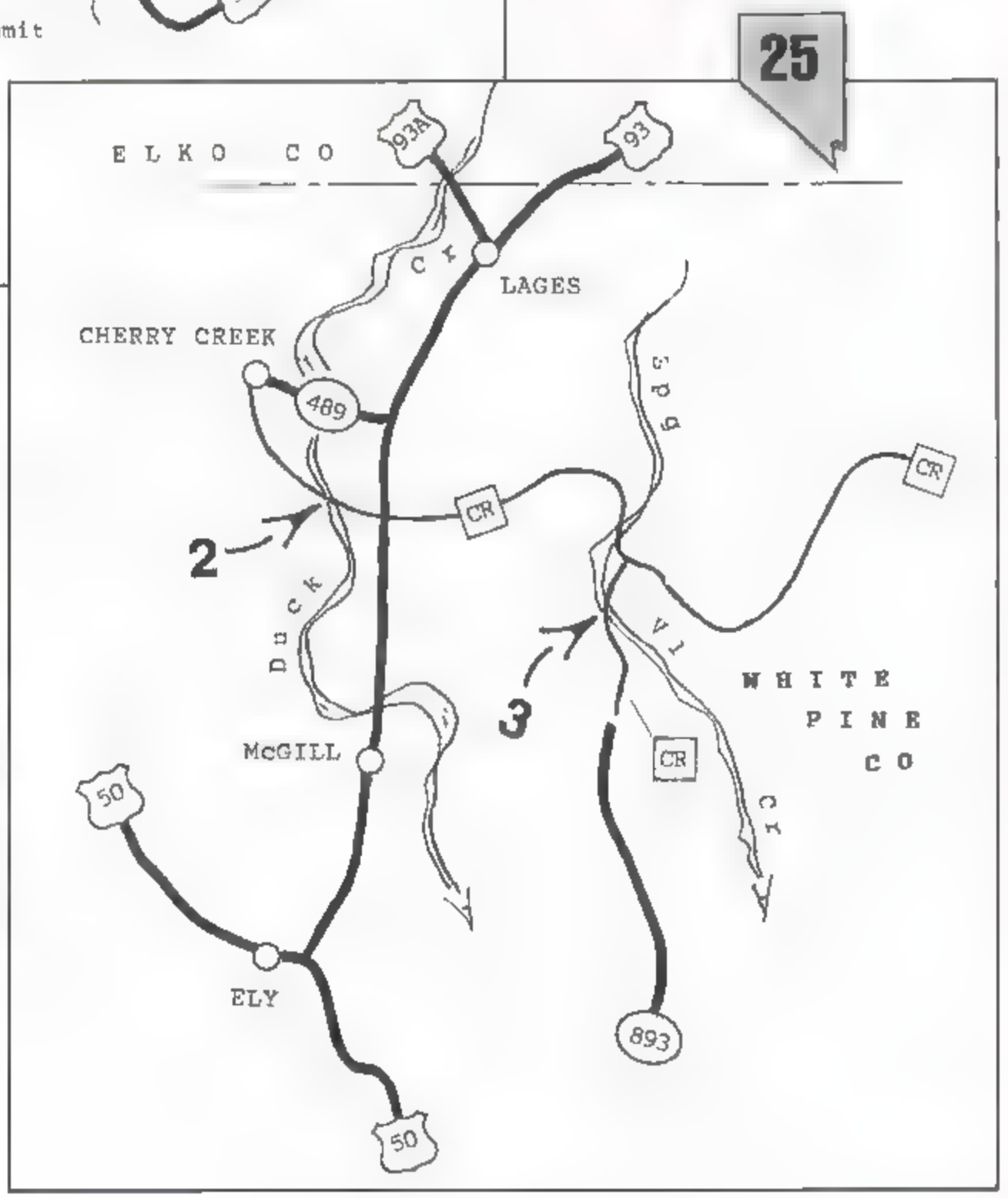


WHITE PINE COUNTY (MAP NV24)

Site 1 **Huntington Creek/County Road** crossing near **Eureka.** Vicinity finds include gold and opal



WHITE PINE COUNTY (MAP NV25)

Site 2 **Duck Creek/County Road** crossing near **Cherry Creek.** Vicinity finds include agate, emerald, and jasper.

Site 3 **Spring Valley Creek/County Road** crossing near **Lages.** Vicinity finds indicate gold potential

FIELD TRIP

Rockhounding California's Santa Ynez River

Jasper Lurks in the Pacific Coast Range

Story and Photos by Craig Andrews

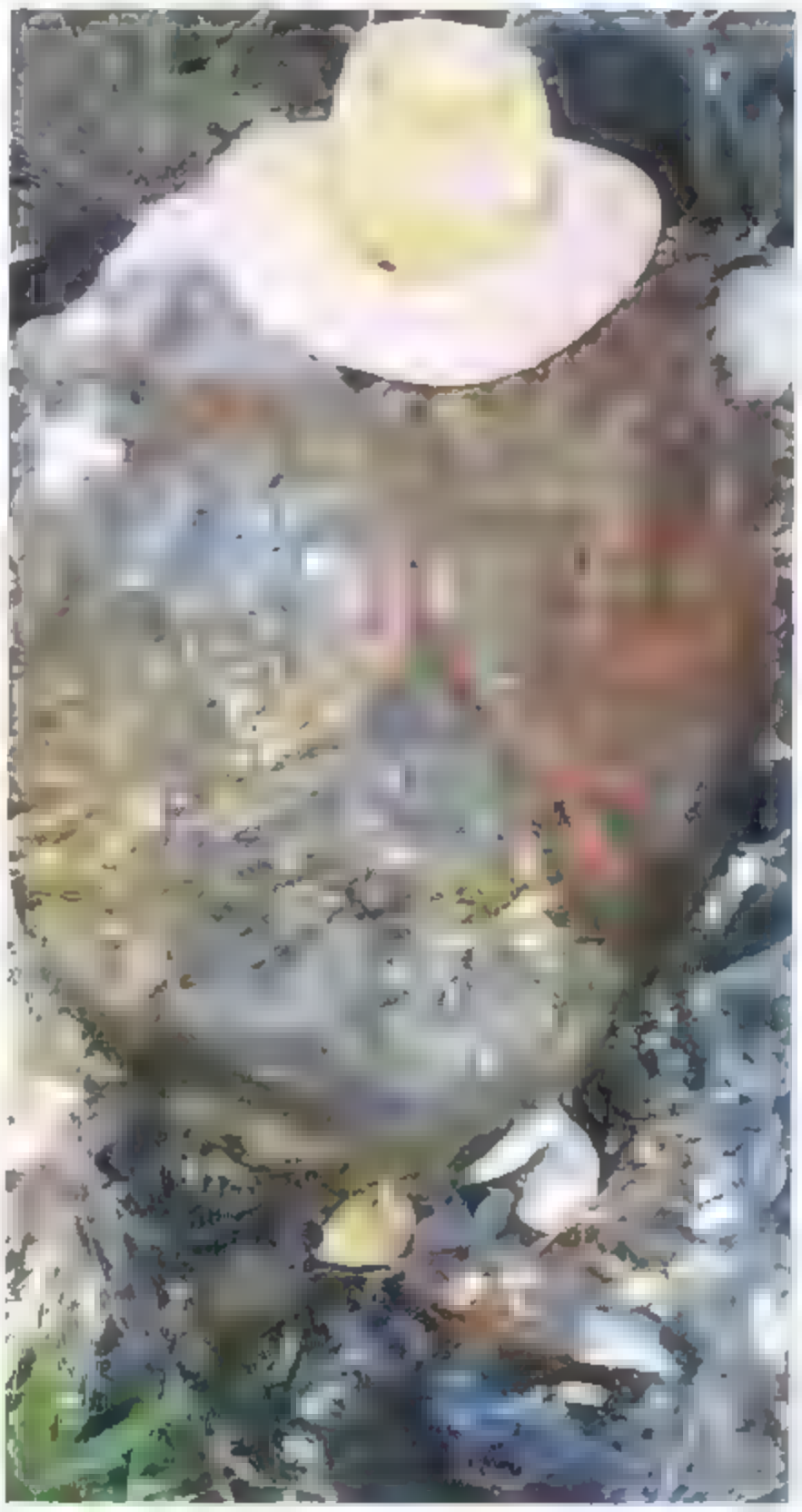
While Oregon and Idaho boast the most famous rare jaspers, California has its own bragging rights, from the world-famous Stone Canyon jasper of Parkfield to Morgan Hill's poppy jasper, to the Mojave Desert's chapenite. In my opinion, the Santa Ynez River, located amid the Transverse Ranges that form a portion of the Pacific Coast Ranges, also ranks as a good locale. Its jaspers are among the most delightful to collect and cut due to the unpredictable variety that can be found. Moreover, in my view, some Santa Ynez jasper is so unique as to be rare indeed.

I slabbed several specimens of Santa Ynez River jasper that show the range of variety one can expect in the rocks gathered from the river and its banks

For decades, I have driven across the Santa Ynez River while traveling state Route 154 (San Marcos Pass) between Santa Barbara and U.S. Highway 101 north of Buellton to visit my parents. I have never been tempted to rockhound the river and the surrounding Santa Ynez Recreation Area mountains, blithely assuming that any rocks would be the sedimentary stones one normally sees in the Pacific Coast Ranges. All those years, I never knew that jasper lurks in those hills.

I learned about Santa Ynez jasper serendipitously. At a gem and mineral show, I found what appeared to be a slab of Stone Canyon jasper, a classic cutting material that is very nostalgic to me because I cut some of my first cabochons from it as a young boy. Imagine my surprise when I asked the dealer if the slab was Stone Canyon and he said, no, it was actually from a rock he found in the Santa Ynez River. I consulted James Mitchell's book (*Gem Trails of Southern California* Gem Guides Book Co., 2003) and found out that, yes, jasper can be found in Santa Ynez River (pp. 168-169).

My first attempt to find some Santa Ynez jasper came a year ago when my wife and I explored one of Mitchell's sites for a couple hours' diversion during a trip north to visit my folks. My wife and I explored the river bottom and banks just east of the White Rock day use area, but were not sure how



Some Upper Oso Creek jasper must be admired in situ because the pieces are too big to move

to find the jasper, given that most of the rocks bore a heavy coating of algae. A rock had to be turned upside down in order to assess its potential.

We did come home with some rocks, and I tried slabbing a few. Most were duds, but my wife had found a nice one, a 5 pounder of a warty-textured, greenish material, that yielded spectacular slices of a golden design interspersed with abstract skeins of maroon and olive green. Clear chalcedony stringers punctuated the jasper, giving it a brecciated pattern, but much different from any brecciated jasper I have seen. The effect is very much like a topographic map, with "rivers" of chalcedony slicing jaggedly through colorful fields broken up by miniature fault lines.

The rock yielded several nice cabochons, and I vibro-lapped the remaining 2-pound chunk into a nice display piece for my wife's desk. Unfortunately, however, none of the remaining rocks turned out to be very nice.

After I asked around, a fellow member of a rockhounds' Internet bulletin board advised me to consider exploring the river above White Rock, especially Oso Creek, a tributary of the Santa Ynez that can be accessed just east of the National Forest's kiosk a couple miles east of White Rock. Finally, a year later, we re-visited the river, focusing on Oso Creek, which this time yielded more nice jaspers, some well beyond the proverbial "fist" size.

continued on next page

Rockhounding *from page 41*

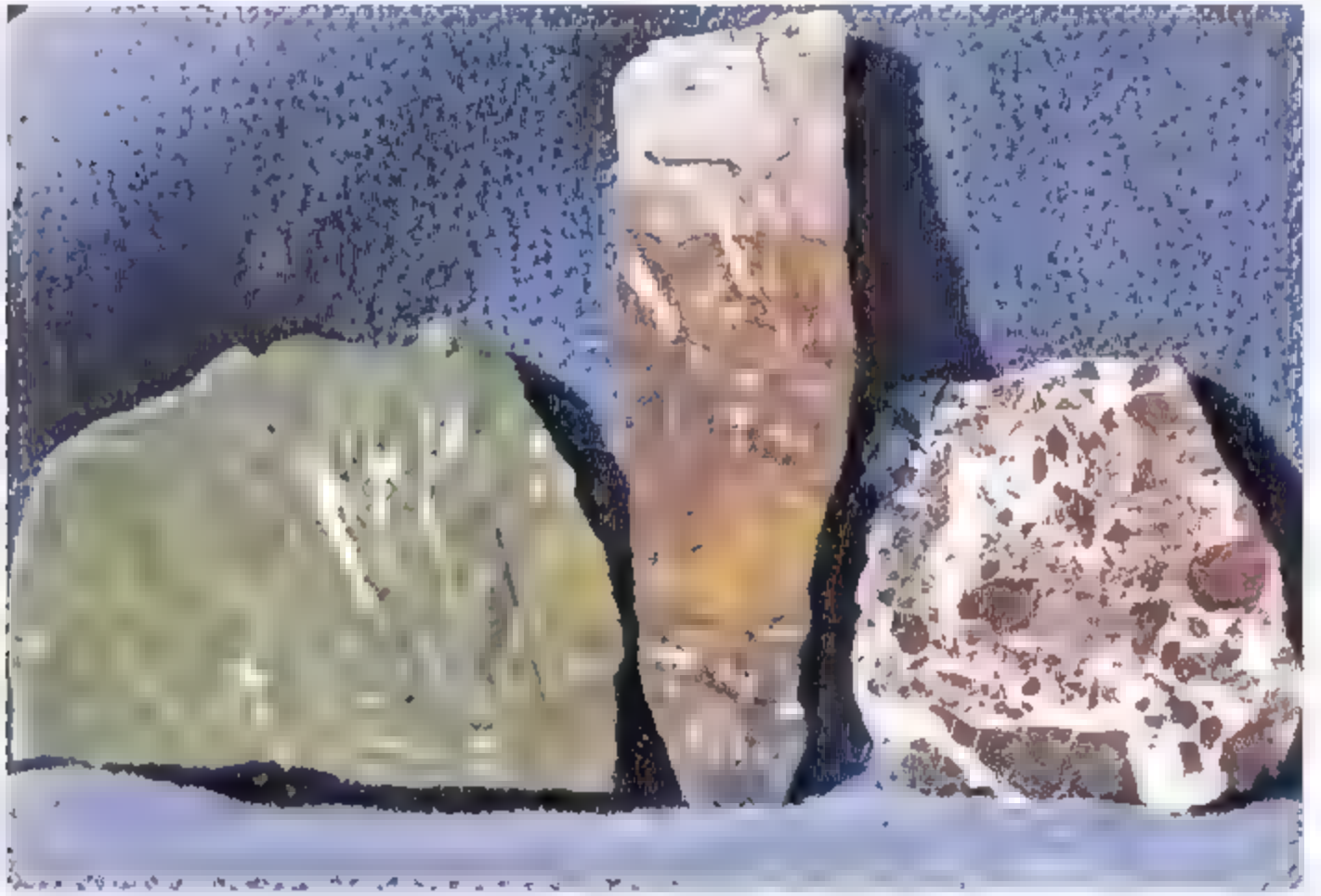
The main reason we experienced more luck during our second trip, I believe, is that we learned how to spot potential candidates quickly. Most river jaspers are hard enough to remain rough and bumpy on their exterior, while the rest of the river rocks – mostly sandstones and the like – have been rounded by millennia of tumbling action. So, when rockhounding the river, look for the rough stones.

One might wonder why, given enough time in the great natural rock tumbler of the river, the jaspers, too, would not eventually become smoothly round. I am guessing that a lot of the jasper is recently weathered out of the slopes and has not had time to become smooth in the river.

There is no shortage of jasper rocks wedged into the tough, dry clay along the river's banks. New rocks undoubtedly join the river all the time, so it seems unlikely that this location will become exhausted. Also, I know of no commercial ventures to remove jasper from the Santa Ynez River. It would take a mighty long stretch of river to yield the tonnage that commercial ventures usually seek. Let's just say that you have to scan hundreds of river rocks before spotting one that may be jasper.

During this second trip, we had more time to look, as the focus of the excursion was rockhounding and nothing but. In fact, we camped for two nights in the area (there are several campgrounds available, and some sites can be reserved in advance). Anyone planning to rockhound the river should expect to spend ample time exploring if they hope to bring home more than a couple rocks. The only caveat about camping I would offer is that, if possible, rockhounds should try visiting during weekdays, especially during the warm summer months when the river is a popular destination for city vacationers. Weekend crowds make it difficult to find a camping spot (unless you have a reservation) and prove an irritating distraction to collecting.

I should note that both of our trips to the Santa Ynez Recreation Area have been during summer months when the river was flowing, its water at times reaching one's hips. When the weather is hot, it feels pleasant to wade in the river looking for rocks, but wear sturdy footwear. The algae-clad rocks are slippery. Even with good shoes, tread carefully, for I took a couple of nasty falls, receiving a heck of a bang on my elbow, which pains me even as I write this.



Clear chalcedony stringers punctuate the jasper, giving it a brecciated pattern.

During summer, the river is warm (just right for swimming) and its perfectly clear water glimmers in the sun like faceted topaz. One can easily view the rocks below when peering through the soft ripples of the glass like surface. The current is gentle and provides welcome cooling from temperatures that can soar into triple digits during the summer.

The most stable cutting jaspers from the area seem to be the ones with predominant gold and burgundy designs, at times verging into mossy areas and transected by chalcedony stringers. I found more of the rocks that have the olive green color, but the first one I have cut turned out to be rather fractured. Currently, I have quite a little pile of rocks waiting for the saw. I'm hoping that I'll have at least one more rock that cuts well, like that first jasper my wife found a year ago.

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Rockhounding California's Santa Ynez River *from page 43*

That a rockhound has to be selective in collecting Santa Ynez jasper is an understatement. While there are many stones that offer ample cabbing areas, some will inevitably be too fractured to use. With experience, a lapidary can determine which rocks are most stable. The fact that the river basically maps a fault line no doubt plays a role in the battered condition of some jaspers.

According to the Santa Ynez Valley Community Plan's January 2004 draft, which I accessed on the Internet at www.countyofsb.org, the Santa Ynez River Fault "is classified as active with evidence of movement in Recent geologic time (i.e. the last 11,000 years)."

When the weather is hot, it feels pleasant to wade in the river looking for rocks

This determination somewhat conflicts with what one encyclopedia Wikipedia (www.wikipedia.org) says of the fault: "no longer considered active."

Wikipedia's listing reports that the Santa Ynez Mountains are geologically "young, and are most entirely sedimentary. They were uplifted in the late Miocene epoch, about 5 million years ago, along the Santa Ynez Fault." One thing that is unusual about the Santa Ynez Mountains is that they trend east-west, one of the few ranges to do so in the United States. The Santa Ynez Valley Community Plan notes that the Santa Ynez Valley is overlaid with "generally unconsolidated alluvial deposits" from the Pliocene to Recent epochs, deposits which "overlie older Miocene marine rocks."

Coming from high in the scenic sandstone bluffs that glare like sentries down upon the Santa Ynez River, Oso Creek tends to contain more jaspers than does the larger Santa Ynez River into which it feeds. During our most recent visit, the largest jaspers I found (boulders) resided in Oso Creek near the Oso campground. Two boulders probably weighed a ton each, but the third one only weighed about 100 pounds. I can only imagine what it would be like to have a huge slice from one of the larger boulders polished and displayed on the wall like an abstract painting.

Given that all three areas of the recreation area (White Rock day use area, the river just east of the kiosk, and Upper Oso Creek just above the Oso campground) where my wife and I have hunted jasper yielded good lapidary stones, it is difficult for me to imagine a rockhound having an unsuccessful outing in this area. It is not one of those places where a person can get out of the car and collect a bucketful in 20 minutes, but in my opinion the Santa Ynez River is very much worth the time to visit. The site is fine for an afternoon outing, but if possible, plan to stay awhile.

Camping is especially pleasant during weekdays. During this last trip, we arrived on a Saturday and stayed through Monday. If you want peace without crowds bringing their boom boxes, you will prefer a weekday, during which the campgrounds will be all but abandoned. The scenery is spectacular, and photographers will delight at the possibilities in visually capturing post-card-quality scenes of the terrain and wildlife. Those with large recreational vehicles will have no problem finding appropriate campsites, but none have utility hookups.

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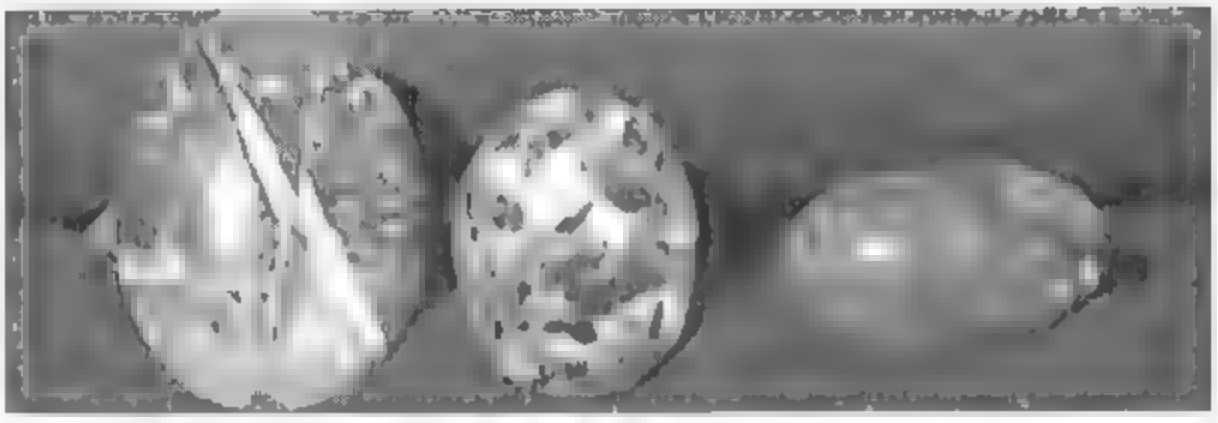
Rockhounding California's Santa Ynez River *from page 44*



Santa Ynez River jasper cabs into dramatic pieces, but one must beware of pits and cracks.

If you visit during the summer, be prepared for heat. The river offers a welcome respite, but sitting in a campsite can get awfully hot during the middle of the day—all the more reason to be rockhounding in the river while the sun is up. I do not know what the conditions are like at other times of the year, but I reckon that early spring would be pleasant, as well, although the river might be cold (and potentially dangerous) then. I suggest checking conditions in advance by contacting the area's National Forest officials.

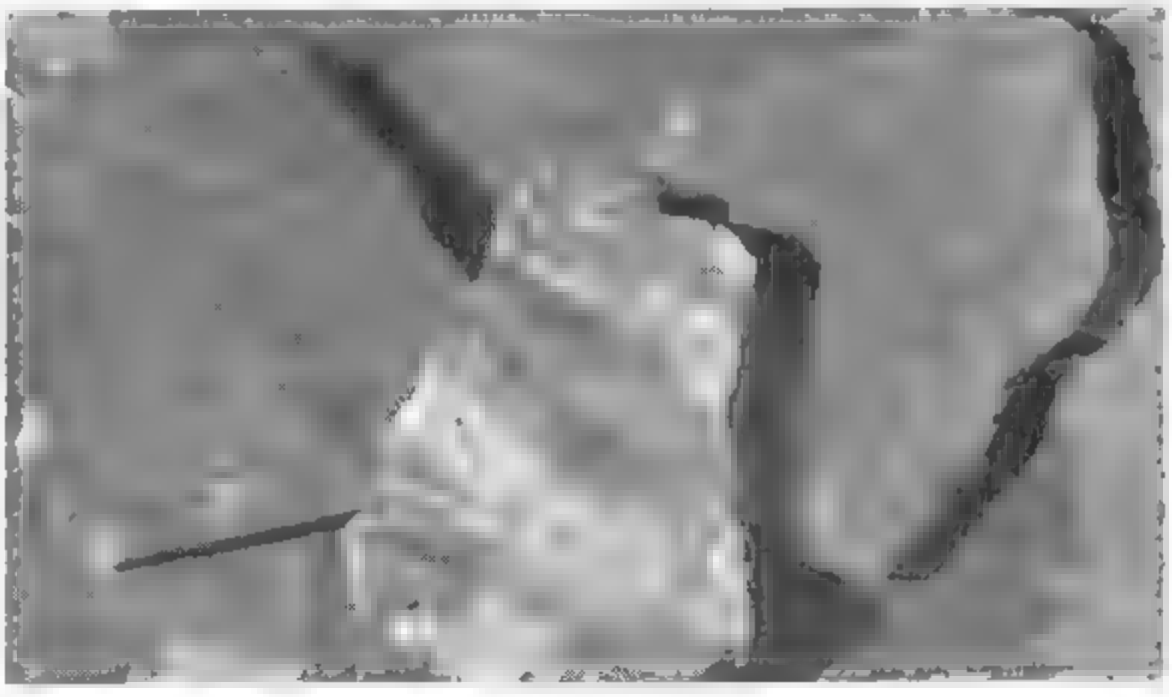
While I won't comment on the worth of a long-distant drive for this excursion, this area would certainly be appropriate for Southern California gem and mineral club field trips. There is even a group campground that a club could book to accommodate its members.

After speaking with an administrator from the Forest Service's Santa Barbara office, I learned that authorities will tolerate the sort of low-impact collecting that might fill a day pack, but for larger collecting amounts, a permit will probably be required. Permits cost $15 and come with stipulations. If I was arranging for a club field trip, I would certainly secure all authorizations and the necessary permit before booking the trip.

In talking with the Forest Service's administrator, I sensed that officials are skittish about authorizing any sort of nonpermitted rock collecting from the river. The gentleman I phoned could not seem to understand that someone would want to collect rocks to cut into decorative jewelry stones, and he kept saying that removal of rocks for landscaping would require a permit. The fact is, I do not feel that the Forest Service knows much about rockhounding, especially how low-impact the activities of a well-managed club field trip can be. Perhaps it is time for us to do some public relations with officials.

To get to the river, head north on U.S. Highway 101 and take state Route 154 (San Marcos Pass) from Santa Barbara. After about 10 miles, take Paradise Road east for 3.4 miles to arrive at White Rock day use area. Lower Oso day use area is 6.7 miles east of state Route 154, past the kiosk and river crossing. Upper Oso camp is 5.5 miles east of state Route 154 and then 1.5 miles north on road 5N15. Heading south on U.S. Highway 101, take the state Route 154 exit just north of Buellton and Paradise Road will be just a few miles past Cachuma Lake.

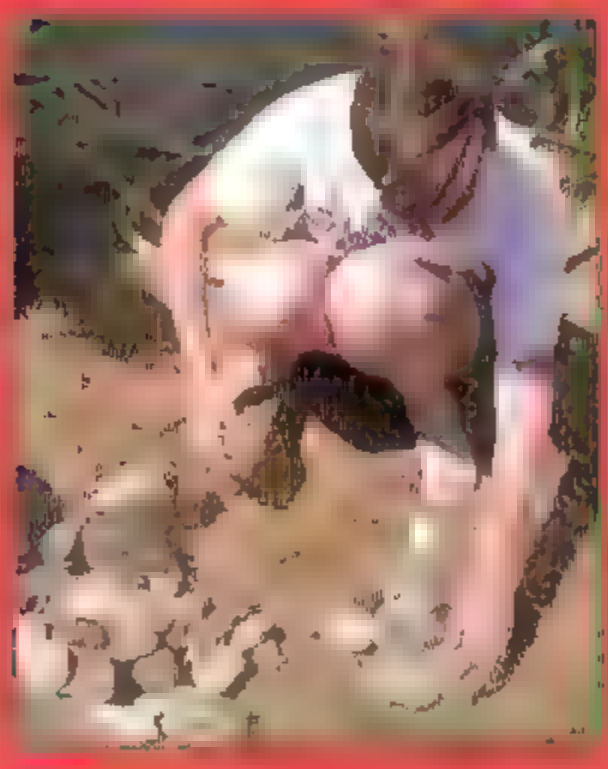
An "Adventure Pass" costs $5 per day, but if you are camping ($15 per night), no day pass is necessary. Group camping costs $75 per night. Campgrounds offer water, flush toilets, level grounds, picnic tables, fire rings, and grills. Paradise, Fremont, Los Prietos, Upper Oso, and Sage Hill (group campground) accept reservations four days in advance. Call (877) 444-6777 or reserve online at www.reserveusa.com. For other information, call (805) 967-3481.



The most stable jasper for cutting is that with gold and burgundy designs. The olive-green rocks tend to be fractured.

ROCK & GEM

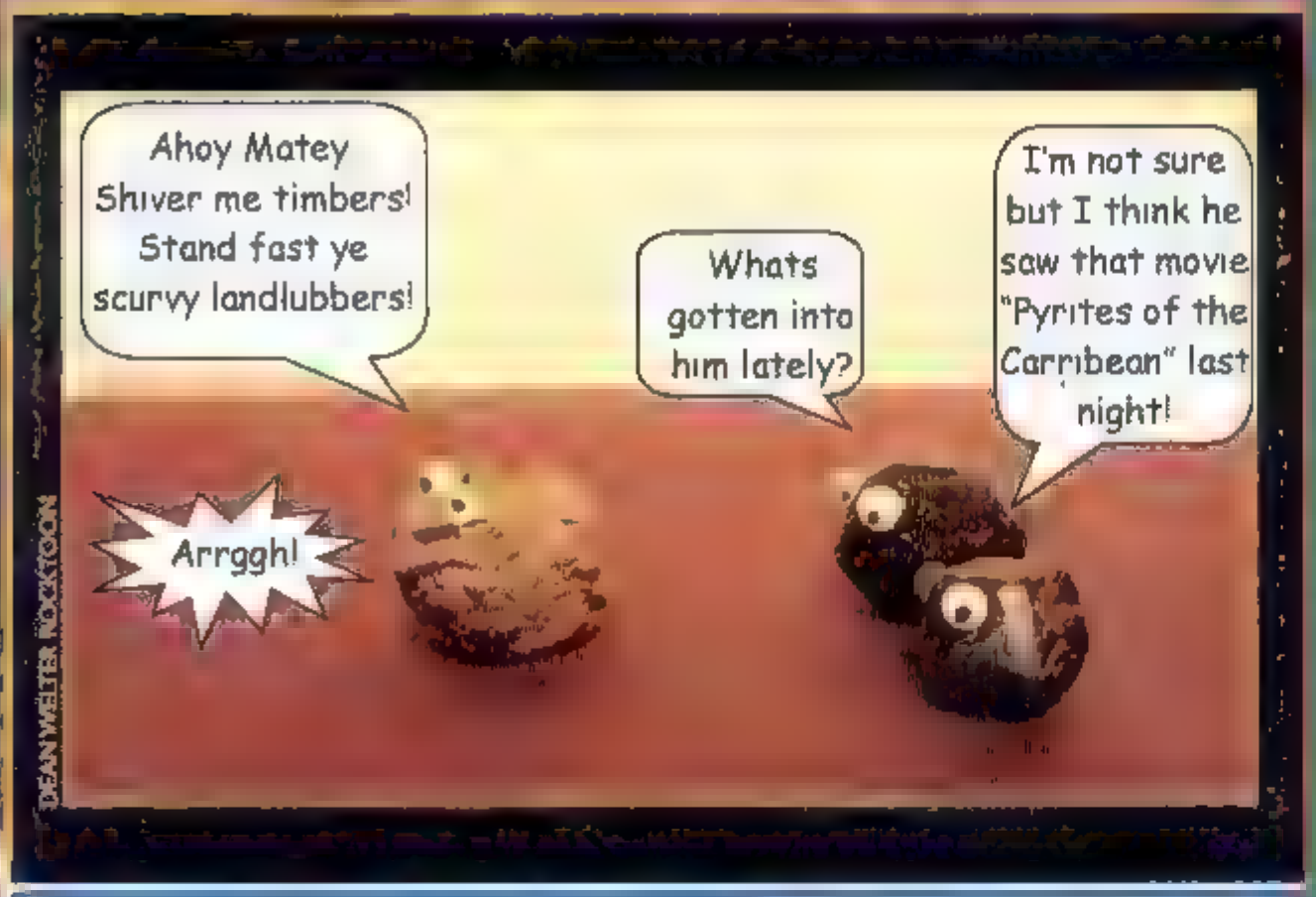
Build a Volcano in Your Backyard



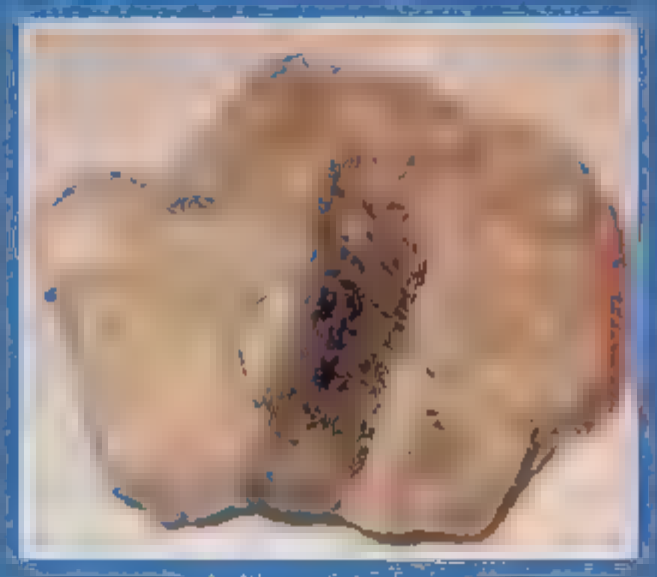
WHAT YOU NEED

KIDS

by Edgar Bick



Zircon



A Piece of Iowa's Past

Fossil & Prairie Park

Floyd Co. Conservation

Fossil Collecting in the Fossil & Prairie Park

Story and Photos by Virginia Reichert

Outdated, exaggerated and disappointing. That is the reaction I've had to many guidebooks claiming to steer the amateur rock and fossil hunter to collecting locations. A day that started off full of exciting possibilities ended with the discovery of a shopping mall on what was written up as a great location for brachiopods. Four hours of scouring a road cut that was described as being loaded with fossils yields a handful of broken pieces. Worse yet, a sinking feeling in your chest is all you get from the sight of a former classic collecting area decimated and pockmarked by disrespectful, greedy collectors. Persistence pays off, though, and I have discovered a bright spot in Iowa that lives up to all that has been written about it. The Fossil & Prairie Park just outside Rockford, Iowa, is worth the drive and fulfills all expectations.

The Fossil & Prairie Park is located on the site of a former quarry for the Rockford Brick and Tile Co. The park became public land in 1990. The park and adjoining center were acquired by and are operated under the auspices of the Fossil Prairie Center Foundation of Floyd County, Iowa. The Foundation is a nonprofit organization made up of individuals supporting environmental education and conservation activities. If you enjoy your visit to the park please consider making a tax-deductible donation to the foundation as a way of saying "thanks."

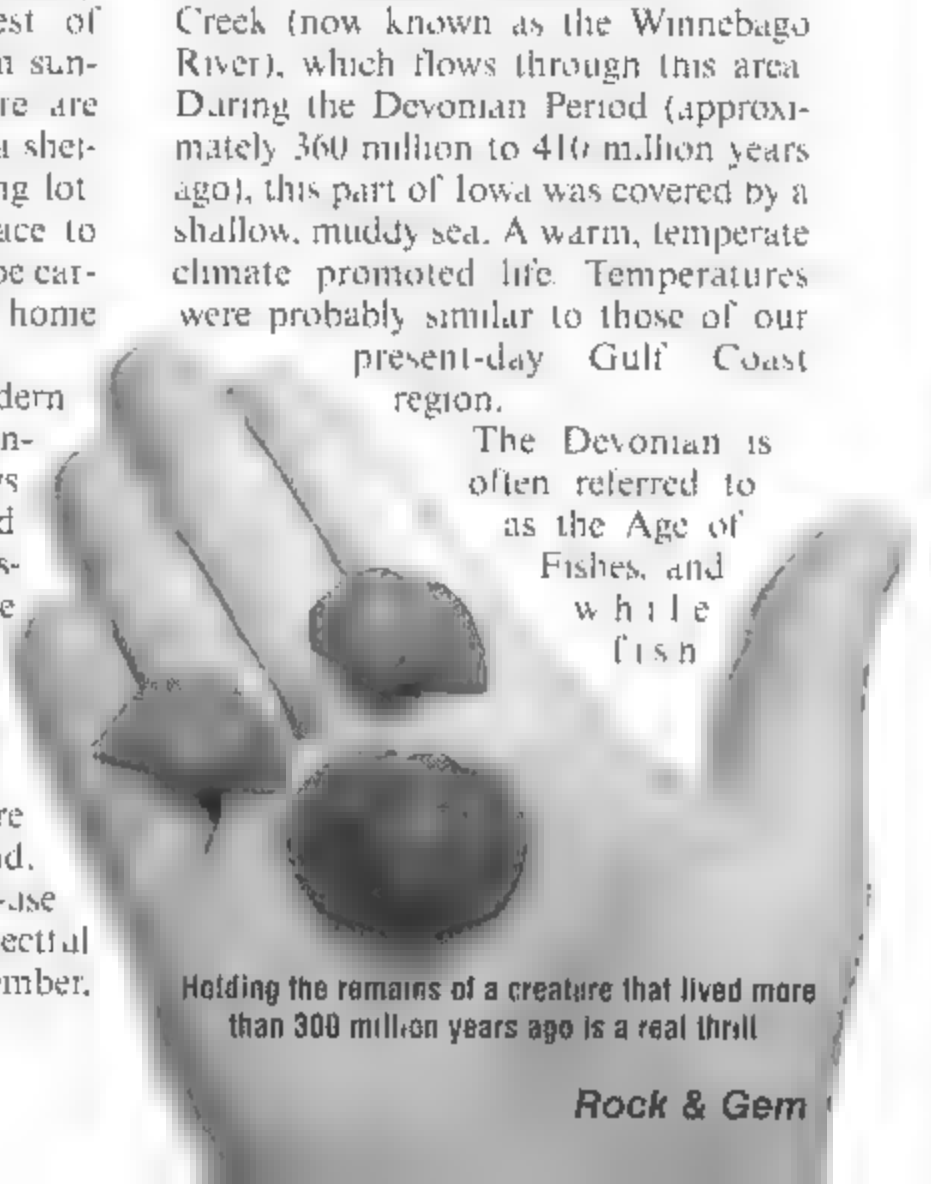
The park and Visitors Center are located at 1257 215th Street (County Road B47), about a mile west of Rockford. The park is open from sunrise to sunset year 'round. There are primitive outhouse facilities and a shelter house located near the parking lot. The shelter house also has a place to wash off your finds so you won't be carrying too much Iowa mud back home with you.

A short distance away is the modern visitors center. This wonderful center opened in 2001 and has displays on the local brick industry and prairie lands and examples of fossils that have been found in the park. Hours of operation are 1-4 p.m. Memorial Day through Labor Day and weekends in May, September and October.

Last, the park is free and you are welcome to take what you find. Limit your collecting to personal-use specimens only, and please be respectful of those that follow you. Remember, this is a limited resource.

One of the many things that make this park so special is that it encompasses an area of Iowa that contains some of the richest Devonian fossil deposits in the state. Floyd County and its neighbor Cerro Gordo County are part of the Lime Creek Formation. The Lime Creek Formation was named for Lime Creek (now known as the Winnebago River), which flows through this area. During the Devonian Period (approximately 360 million to 410 million years ago), this part of Iowa was covered by a shallow, muddy sea. A warm, temperate climate promoted life. Temperatures were probably similar to those of our present-day Gulf Coast region.

The Devonian is often referred to as the Age of Fishes, and while fish



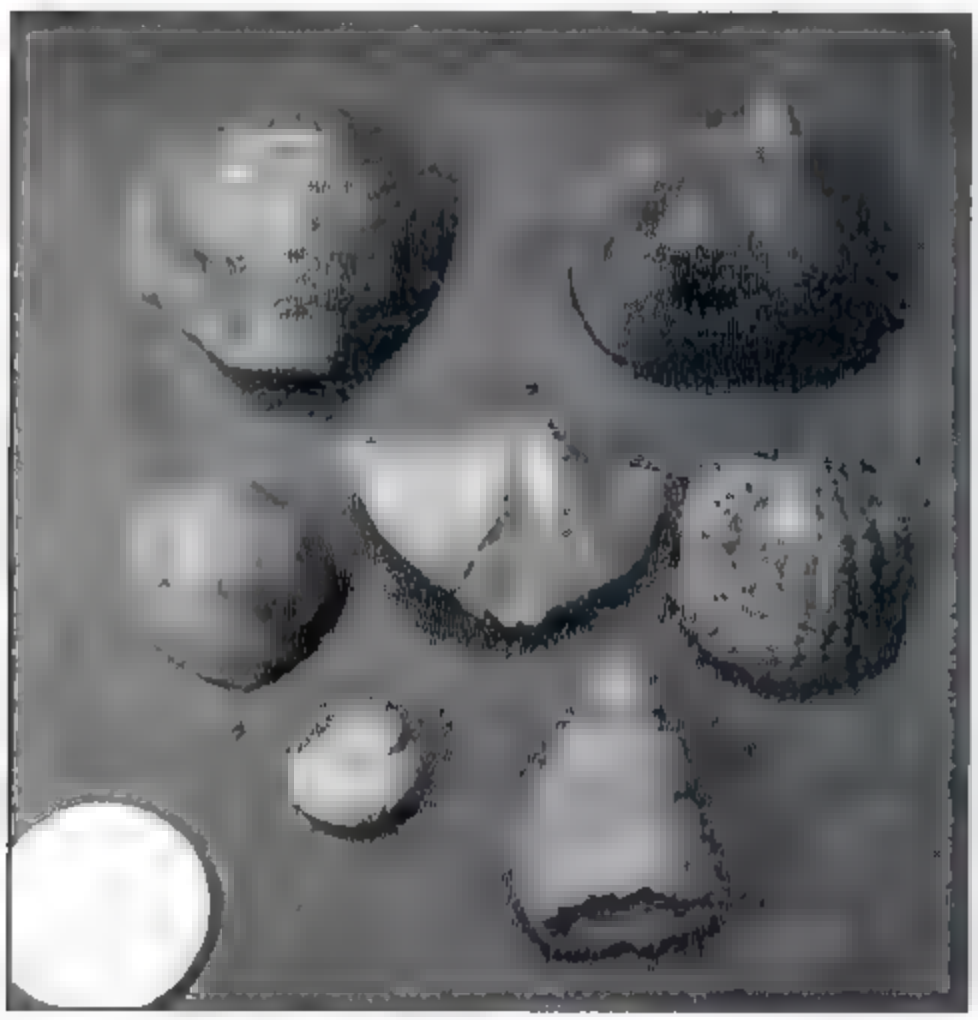
Holding the remains of a creature that lived more than 300 million years ago is a real thrill.

fossils are not common finds in this part of Iowa, the area was certainly teeming with life and marine invertebrates are well represented in the local fossil record. Corals were prolific, growing to large sizes and congregating into extensive reefs. Trilobites, a favorite among fossils collectors, were starting to decline, but were still prolific in certain areas, as were crinoids. Cephalopods, gastropods, and other mollusks were on the move, invading new territory.

Brachiopods were near their peak and today represent probably the most common Devonian fossil find. The brachiopod is such a well known representation of the Devonian Period that the town of Rockford, Iowa uses it in its town logo to support its claim of being The Home of the Devonian Fossil. At least 38 species of brachiopods have been identified as occurring in the Lime Creek Formation (*Iowa's Geological Past*, Wayne Anderson, Iowa State Univ Press, 1998). When the first geologic survey of Iowa was done in 1858, previously unknown fossilized remains of spiriferid brachiopods were discovered, and from that point onward, the fossils of the Lime Creek Formation have attracted the attention of scientists worldwide.

The average collector may not even be aware of it, but the Fossil & Prairie Park is an excellent resource for microfossils. Mixed in among the brachiopods shells, corals, gastropods, bryozoans, and bits of crinoids that are commonly found in the park are important microfossils. They serve as index fossils that help relate the deposits in Iowa to other Devonian formations around the world. Plant spores are common microfossils that may seem boring to the average collector. Conodonts—the jaw pieces of a tiny eellike creature—on the other hand can look quite fierce and are fun to find. To get an up-close look at what's in all the rock you will be walking on, check out the Web site www.eeob.iastate.edu/faculty/DrewesC/htdocs/fossil-buttons.htm. For those with keen eyesight and determination, the quest for microfossils opens up a whole new realm of collecting.

No special tools are needed to find common fossils at the Fossil & Prairie Park.



Small gastropods and brachiopods in stone matrix are common finds in the Fossil & Prairie Park quarries

Close to 200 species of invertebrate and microfossils have been described and cataloged from the Lime Creek Formation, but many have not yet been studied (Anderson, 1998). Who knows what information they will yield? Geology and paleontology are not static sciences. Every day, we can learn something new about ourselves and the planet we live on by looking at the remains of the past. In 1993, floodwater scoured out several feet of glacial deposits near Coralville Lake in Johnson County, just north of Iowa City. Thousands of people flocked to see the remains of a 375 million-year old sea floor. In a relatively short period of time, Iowa got a new tourist attraction and the scientific community got a whole new "library" of information.

The rock composition of the Lime Creek Formation is characterized as being calcareous shale and argillaceous limestone. These shale and clay deposits are excellent raw materials for the production of bricks and tile. The Rockford Brick and Tile Co. made good use of this resource. Clay was extracted for brick and the production and the limestone "waste" was pushed aside. All this waste is now a collector's treasure trove of fossils. Fossils weather free from the limestone and are easily collected on the ground. No special tools are required.

On your first visit, the 400-acre park may seem overwhelming in its size and possibilities and you may not know where to start looking. On the day I was there, the visitors center attendant was more than happy to point out her favorite collecting spots, give me a bag to hold my finds, and wish me luck. You really do not need any special direction or great luck to find the fossils, though.

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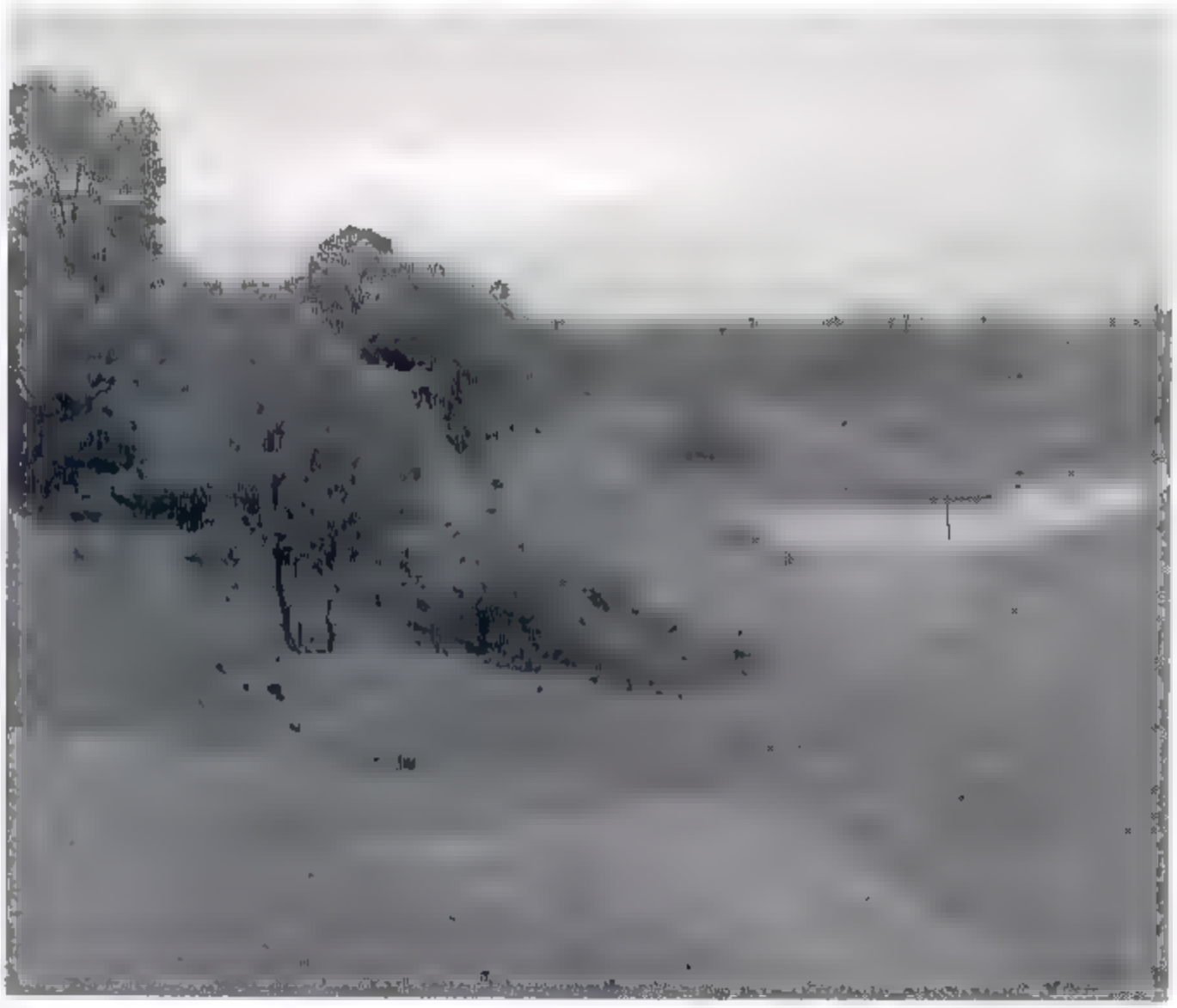


There are areas of water and muck, so pay attention to your surroundings as you explore.

Once you follow one of the hiking paths back into the quarried areas and start looking around, you will start to find fossils. The farther back into the quarry you go, the less picked over the ground will be.

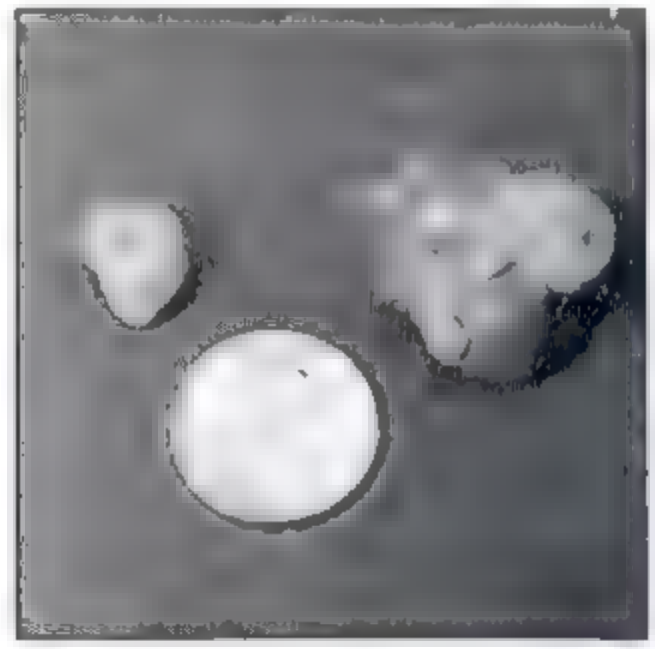
The Fossil & Prairie Park is visited by an estimated 10,000 people each year, many of them school groups who don't wander too far into the quarry. Getting farther back into the quarried areas will give you the feeling you are the only one out there. In fact, on the day I was there, it had rained heavily for most of the morning and I was indeed the only visitor. Visiting the park on a rainy day can actually be a bonus. The rain helps uncover fossils that you might not normally notice.

Collecting along the side of the paths can be rewarding, but the real fun comes from scrambling up and down the hills. Make use of the gullies as you go up and down, and soon you will be going from one find to the next. Rain water speeds along the weathering process and fossils will be lying right out in the open. The small outwash deposits at the base of the gullies are an excellent place to look for those smaller specimens, too. In no time at all you will fill your collecting bag with nice examples of Devonian fossils. Footing can be treacherous on some of the slopes and there are areas of muck and water, so be aware of your surroundings as you explore.

Hopefully, a visit to the Fossil & Prairie Park will spark interest in the geology of the Midwest and of Iowa in particular. This is an excellent park for introducing children to the fun and excitement of rockhounding. Specimens are relatively easy to find and are in such good shape that identification is simple. You can't help but get excited as you touch the remains of ancient creatures and stop to think about what a different landscape Iowa had more than 300 million years ago.

Other geologic sites of note in Iowa for those interested in fossils include the previously mentioned Coralville Lake area, dubbed Devonian Fossil Gorge, Bird Hill in Cerro Gordo County, a one acre plot formerly known as Fossil Hill that serves as an important reference area for the Lime Creek Formation fossil record, and Claybanks Forest State Preserve, also in Cerro Gordo County, which contains outcroppings of the same fossil-laden stone you will find in the Fossil & Prairie Park. No collecting is allowed in these locations, though. Leave what you see here for everyone to enjoy.

Iowa has long been famous for the crinoids found near Le Grand. Old fossil-hunting guidebooks will often steer you in this direction. Complete crinoid fossil finds are very rare these days and the quarries of Le Grand haven't yielded any good specimens in years. You can get a good look at those crinoids,



Small gastropods and brachiopods in stone matrix are common finds in the Fossil & Prairie Park quarries

though, through the famous efforts of Iowa collector B.H. Beane. He is world renowned for his collection and preparation of crinoid fossils found in the quarries of Le Grand from 1890-1937. He and his son, Lewis, used needles and toothbrushes to chip away the stone matrix and showcase crinoids in the slabs of stone they rescued from the quarry. A generous portion of his collection can be found at the State Historical Society in Des Moines, as well as at several regional colleges.

When it comes to identification of Iowa fossils and a specific reference to state geology, an excellent resource is *Iowa's Geological Past* by Wayne Anderson (Iowa State Univ. Press, 1998). Many consider this book to be the definitive word on Iowa geology. Anderson includes clear illustrations of common Iowa fossils and has an accessible writing style that anyone can enjoy. This book would make a valuable resource in any rockhound's library.

Rocks from the Devonian Period are economically valuable to states lucky enough to have them. Limestone, gypsum, clay, shale and dolomite are all important building blocks in our modern world. The materials used in our roads and the brick and concrete of our buildings are made out of deposits from the ancient world. Whether we realize it or not, every day of our lives we touch that past. Making a tangible connection to that ancient world is what the Fossil & Prairie Park is all about. A day spent looking for fossils and walking through the prairies can help you reach out and touch a piece of that past. It's an added bonus to be able to bring a piece of it home with you. So get out, get dirty, and have fun.

To help you plan your trip, visit www.fossilcenter.com and www.uiowa.edu/uiowapress.

Monty Holmes operates Chaffee County's Lost Mine tour, a back-country excursion to the 90-year-old manganese ore mine.

COLORADO'S CHAFFEE COUNTY

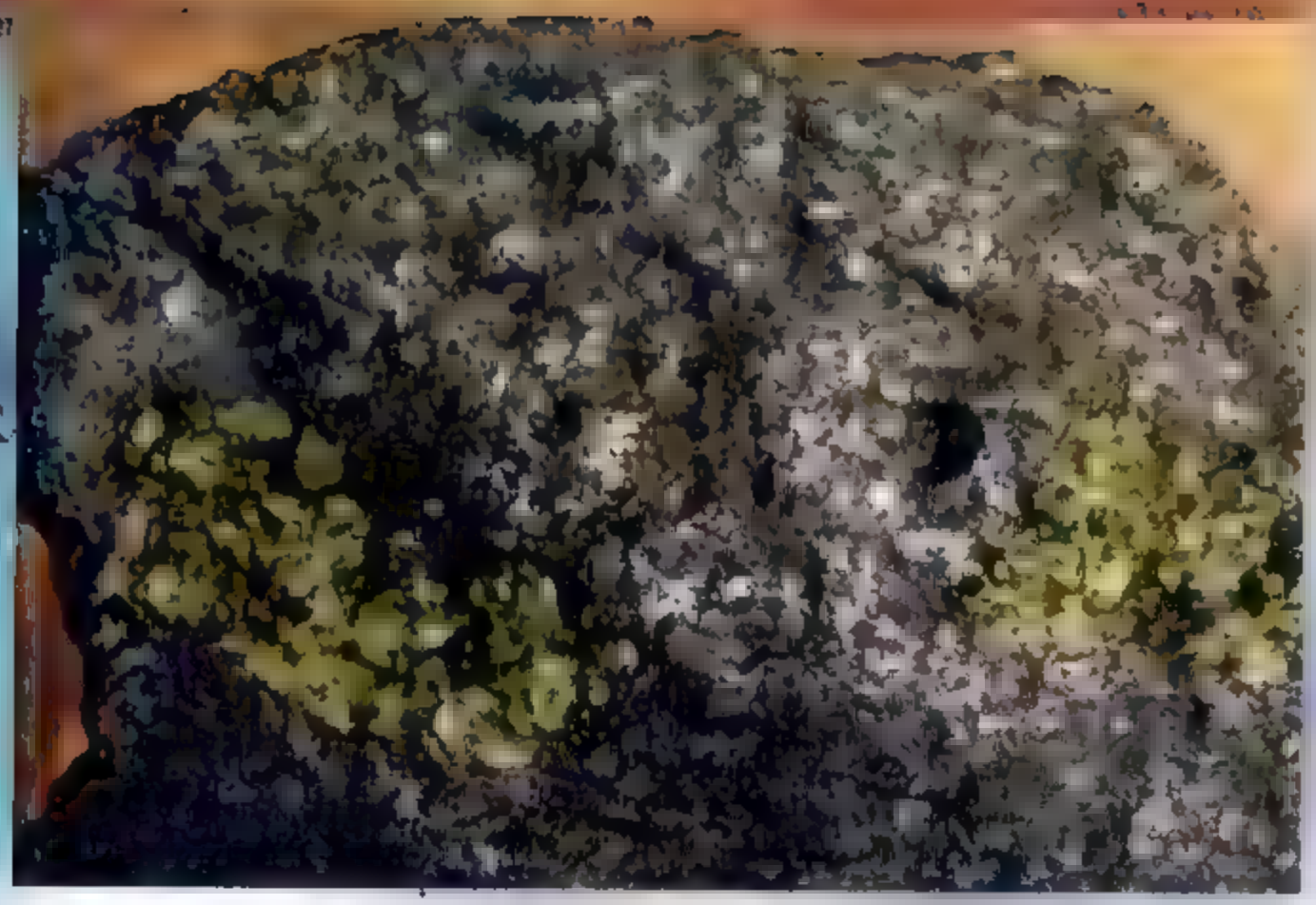
A Rockhounding Vacation Destination with Lots to Offer

Story and Photos by Steve Voynick

With so many interesting mineral-collecting sites across the country, choosing a single destination for a rockhounding vacation can be a daunting task. Too often, a single destination means a single site, with hours of driving required to reach another locality that offers a different mineral.

With that thought in mind, my suggestion for a rockhounding vacation destination is Colorado's Chaffee County. Chaffee (CHAY-fee) County is near the center of Colorado, roughly 80 highway miles west of the cities of Colorado Springs and Pueblo. This laid-back mountain county has a population of just 17,000 and only two towns of any size: Salida (sah-LIE-dah) and Buena Vista.

Placer gold can be mined from the Arkansas River near Granite in northern Chaffee County.



The Badger Creek peridot locality is a family-friendly site for collecting gem-quality material.

Chaffee County is one of Colorado's smaller counties, measuring only 50 miles in length and averaging 20 miles in width. Because of its relatively small size, certain observation points provide a panoramic view of virtually the entire county. One of these is the 14,269-foot-high summit of Mount Antero where, on most summer days, as many as 100 folks will be enjoying this view—when they're not busy searching for crystals of aquamarine, smoky quartz, and phenakite.

Regions with an abundance of mineral-collecting sites usually have an interesting geological story, and Chaffee County is no exception. The county's two most prominent geological features are a string of 14,000-foot peaks and a valley that is part of a major continental rift system. The peaks were created by dramatic crustal uplifting, while the valley, just six miles away and 7,000 vertical feet lower, was formed by crustal subsidence. The extreme displacement between these adjacent sections of crust makes for great mountain scenery, while the associated geological faulting accounts for the county's unusual concentration of gemstone and mineral collecting sites.

The high peaks originated some 65 million years ago during the Laramide Orogeny, the mountain-building event that created the modern Rocky Mountains. Tectonic stresses buckled the crust across much of western North America, uplifting blocks of Precambrian basement rock and overlying Paleozoic and Mesozoic sediments. Because of the unusual intensity of the local uplifting, Chaffee County is home to 12 of the 54 Colorado peaks that are higher than 14,000 feet. The county's western boundary is the Continental Divide.

The intense faulting that preceded and accompanied the Laramide Orogeny enabled magma to intrude the country rock and form batholiths, sills, dikes, and other intrusive bodies. The slow cooling of residual pockets of magma formed the pegmatites that host the Mount Antero aquamarine. Associated superheated, mineral-rich solutions also formed deposits of metallic gold and lead, zinc, silver and copper mineralization.

Much later, what is now Chaffee County became the site of a major geological rift. Rifts form when long blocks of crust drop or displace downward between parallel fault systems. The world's most spectacular rift valley is occupied by the Red Sea, which separates Africa from the Arabian Peninsula. Other prominent rift valleys include the East African Rift, Europe's Rhine Valley, and the Gulf of California (Gulf of Baja).

In Chaffee County, the north-south oriented Arkansas River Valley is the surface manifestation of the Rio Grande Rift, a part of the much larger Great American Rift that extends from central Mexico north into Canada. This rift formed some 39 million years ago when a pair of parallel, major fault systems along a weakened section of the North American continental plate became active.

Simultaneously, a massive upwelling of magma far to the west slowly raised the greater American Southwest to its current elevation. This regional "doming" stretched the Earth's crust in an east-west direction. In what is now Colorado and New Mexico, the crust pulled apart in a line perpendicular to the fault systems, enabling long, narrow sections of crust between the faults to slowly drop and creating the Rio Grande Rift.

Along the edges of the rift, deep faults penetrated the entire thickness of the continental plate to serve as conduits for magma from the underlying mantle to reach the surface. The resulting volcanism along the eastern edge of the rift created basaltic fields and rhyolite "necks" that are now popular gemstone and mineral collecting sites.

One of these volcanic sites is Ruby Mountain, a Tertiary rhyolite dike that intrudes Precambrian granite and gneiss country rock. This gray-white rhyolite has faint, parallel, pink-and-purple banding and contains numerous gas cavities from 1 to 12 inches in length. All are lined with white crystals of sanidine (orthoclase feldspar) and some contain crystals of topaz and the garnet-group member spessartine.

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Because most of Chaffee County's rivers and creeks are gold bearing, panning and recreational mining are popular activities there.

Colorado's Chaffee County *from page 65*

Most of these garnet crystals are quite small, although sizes up to 4 millimeters are not hard to find. Extraordinary specimens can measure 12 millimeters (about ½ inch). Colors range from brown-red to deep blood-red; smaller crystals are usually a bright hyacinth red. The crystals occur as brittle dodecahedrons showing as many as six smooth, glassy faces. Ruby Mountain is named for the garnets, which resemble faceted rubies.

The less common topaz occurs in slender prisms about 3 millimeters in length, but exceptional specimens are as long as 12 millimeters. Colors range from light yellow to sherry. Collectors can find spessartine and topaz crystals simply by sorting through the talus rock, but most break the rhyolite with heavy hammers to expose new cavities. Obsidian nodules, or Apache tears, occur in perlite pockets at the north and south ends of Ruby Mountain.

The Ruby Mountain turnoff is about six miles south of Buena Vista. From U.S. Highway 285, turn east on County Road 47 and follow the signs for four miles to Ruby Mountain. Observe the land-access signs, for Ruby Mountain includes both public and private lands.

From Ruby Mountain, the view west across the Arkansas River Valley takes in Mount Antero, 30 miles away. Mount Antero's fame as a crystal-collecting locality is due to a maze of granite-pegmatite pockets that originated before the mountain was uplifted. Some 80 million years ago, hot, silica-, beryllium-enriched magma intrusions solidified into granite that contained crystal-lined, manholelike cavities from 1 foot to as many as 20 feet long. At that time, the pegmatite zone was near sea level. Later, the Laramide uplifts raised these pegmatites to their current elevations. During the uplift, rock deformation collapsed the hollow, crystal-lined pegmatite pockets.

As subsequent erosion eventually exposed some of these collapsed pegmatite pockets, crystals weathered free onto the surface, where they were discovered in 1880.

Today, even after 125 years of collecting, float crystals of smoky quartz, phenakite, and the aquamarine variety of beryl are regularly found among the talus. And each year, serious collectors open new pegmatite pockets using hammers and chisels.

Although summer conditions high on Mount Antero are usually pleasant, sudden weather changes can bring high winds, cold temperatures, dangerous electrical storms, and even snow. The air is thin and the talus slopes are steep, rugged and hazardous. High-elevation snowfall generally limits the collecting season from late May to early September.

To reach Mount Antero from U.S. Highway 285, take state Route 162 west seven miles, then turn south on Forest Service Road 277, a steep, rough road that requires a four-wheel-drive vehicle in good running order. Proceed 3.5 miles, take the left fork, toward Baldwin Creek, and continue for three additional miles to a small parking area at an elevation of about 12,500 feet from which trails continue upward.

To reach the ghost town of St. Elmo, just four miles west of Mount Antero, continue west on state Route 162. St. Elmo boomed in the 1880s when its mines exploited the mile-long Mary Murphy vein. By the time these mines closed in 1952, the St. Elmo district had produced $25 million in gold, silver, and base metals. The primary sulfide ore minerals are chalcopyrite, galena, and sphalerite; the oxidized ore minerals include cerussite and smithsonite. Among the gangue-rock collectibles is a fine-grained mixture of rhodochrosite, rhodonite and quartz. Although some mine dumps in the St. Elmo area have been reclaimed, others still yield specimens.

Notable mineral collecting areas usually seem to have an outstanding rock shop, and in Chaffee County it's The Rock Doc. The Rock Doc (www.therockdoc.net), at Prospectors Village, is located on U.S. Highway 285, five miles south of the junction with state Route 162. Owner Cindy Peratt is a geological engineer with first-hand knowledge of local collecting sites. The Rock Doc is stocked with dredges, prospecting tools, books, maps, and thousands of mineral specimens, many from nearby sites. The Rock Doc has become the headquarters for many Chaffee County mineral collectors and gold miners.

Just a few miles south of Prospectors Village on U.S. Highway 285 is the Browns Canyon Fluorspar District, where mine dumps contain fluorite, barite, calcite, pyrite, and iron and manganese oxides. Fluorite, mostly botryoidal, but occasionally as small cubes and octahedrons, occurs over a three-mile-long fault section in veins associated with chalcedony. This district's small mines yielded $5 million in fluorspar between 1929 and 1980. Browns Canyon fluorspar ores are usually white or gray with light shades of red, brown or green. From U.S. Highway 285, county roads 193 and 194 access the district.

The previously mentioned St. Elmo district exploited sulfide-type mineral deposits emplaced in the complex local fault systems. Similar mineralization occurs in the Monarch district, where the booming camp of Garfield was founded in 1878. When its mines finally closed in 1952, district production amounted to $16 million in lead, silver, copper and gold. Minerals in the district's replacement and contact-metamorphic ore bodies include argentiferous cerussite, pyrite, native copper, chalcopyrite, bornite, covellite, galena, and smithsonite. To reach the Monarch district from Salida, follow U.S. Highway 50 west for 13 miles to Garfield, where roads turn north to the old mines.

Another interesting site is the Sedalia copper-zinc mine, just a few miles northwest of Salida near state Route 291. Between 1884 and 1914, the Sedalia turned out $500,000 worth of copper, zinc, gold, and silver. Its dumps still yield specimens of both oxidized and sulfide copper, zinc, and lead minerals, along with large crystals of almandine garnet.

Another sulfide mineral district and a pegmatite-mining district are located north of Salida. From state Route 291, follow County Road 175 (Ute Trail) north for 7.5 miles, then turn left on County Road 185 and proceed two miles to the mines. The Turret District opened in 1882 with the development of the Calumet Mine, which exploited a large vein of magnetite iron ore. The Calumet Mine is today a noted source of fine epidote crystals, which occur in partially altered limestone. The same limestone-marble beds also yield grossular garnet and Colorado's only sapphires, which, although a pleasing blue, are not gem quality.

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Colorado's Chaffee County *from page 67*

In 1900, miners founded the town of Turret after discovering small deposits of gold, silver, and base metals nearby. Then in the 1950s, a group of pegmatite quarries produced beryl and columbite-tantalite. The quarries offer nice specimens of muscovite and biotite mica, white albite, pink microcline graphic granite, clear and white quartz, and fragmented green beryl.

The Badger Creek peridot locality is located just four miles farther north along Forest Service Road 175 and just across the Chaffee-Fremont county line in San Isabel National Forest. Peridot is the lime-green gem variety of the olivine-group mineral forsterite. Olivine-group minerals, which are essential components of basalt and other silica-poor extrusive rocks, form in the high-temperature, high-pressure conditions of the Earth's upper mantle and are carried to the surface in magma rising through deep faults.

The Badger Creek peridot site is part of the 39-Mile Volcanic Field, a 200-square-mile area of ancient volcanic activity where basalt outcrops have weathered into a dark soil. In places, this soil contains several hundred carats of peridot per 5-gallon bucket of soil. Badger Creek peridot, which is recovered by screening the soil, has been faceted into attractive gems for jewelry. As always, observe land-access signs, especially claim notices.

Since 1860, miners have recovered an estimated 100,000 troy ounces of placer gold in Chaffee County. The Arkansas River and most of its tributaries are gold bearing. Sections of the Arkansas near the tiny unincorporated village of Granite in northern Chaffee County have been dredged or ground sluiced and are still popular gold-panning areas.

The Gold Basin Mine, at the lofty elevation of 12,300 feet, is an active, commercial placer mine where visitors can pan, dredge, sluice, and metal-detect for gold on a fee basis. Located seven miles west of Granite and 3,800 feet higher, the mine is reached via Chaffee County Road 398 (Lost Canyon Road). This graded gravel road is passable for most highway vehicles, but the last mile is rough and best handled by four-wheel-drive vehicles.

In Salida, visit the Gem Factory at the corner of First Street (state Route 291) and F Street. If you can't explore Mount Antero, this is the place to see the local aquamarine as both rough crystals and faceted gems. Owner Mark Krivanek, a master gem cutter and graduate gemologist, owns and works claims on Mount Antero.

Visitors can also tour the Lost Mine (www.salida.com/lostmine), a 90-year-old underground manganese mine just east of Salida. The tour, personally conducted by mine owner Monte Holmes, departs from Salida. It includes a back-country excursion to the mine, which exploited pyrolusite and psilomelane ores.

In August, don't miss the Con-Tarl Gem & Mineral Show at the Buena Vista Rodeo Grounds. It's sponsored by the Colorado Federation of Gem & Mineral Societies (www.coloradorocks.org). The Columbine Gem & Mineral Society (PO Box 122, Poncha Springs, CO 81242) hosts the show. The club is headquartered in Salida and meets on the second Thursday of each month.

Although well off the interstates, Chaffee County is served by U.S. Highways 24, 50 and 285. The important road-junction communities Salida and Buena Vista together have more 700 motel rooms, many of them new.

When collecting in Chaffee County, keep elevation in mind. Salida, one of the lowest points in the county, has an elevation of about 7,500 feet. Buena Vista's elevation is nearly 8,000 feet and many collecting sites are higher. At Mount Antero and the Gold Basin Mine, both above 12,000 feet, thin air can be a concern for some individuals. Those prone to altitude sickness often spend a day or two at Salida to acclimate to the higher elevation.

Summer is the best time to collect in Chaffee County—and the only time to collect at such higher sites as Mount Antero, St. Elmo, and the Gold Basin Mine. But Chaffee County, especially the Arkansas River Valley, has warmer temperatures and less snow than adjacent mountain areas, so collecting at lower sites like Ruby Mountain is often possible during the winter.

For those looking for a rockhounding vacation destination with a lot of great collecting sites conveniently located in a small geographical area, Colorado's Chaffee County is a real "Rocky Mountain high."

For general information about Chaffee County, contact the Heart of the Rockies Chamber of Commerce in Salida (719/539-2068, www.salidachamber.org) or the Buena Vista Chamber of Commerce (719/395-6612, www.fourteenernet.com/buenavista).

Hershey Hematite

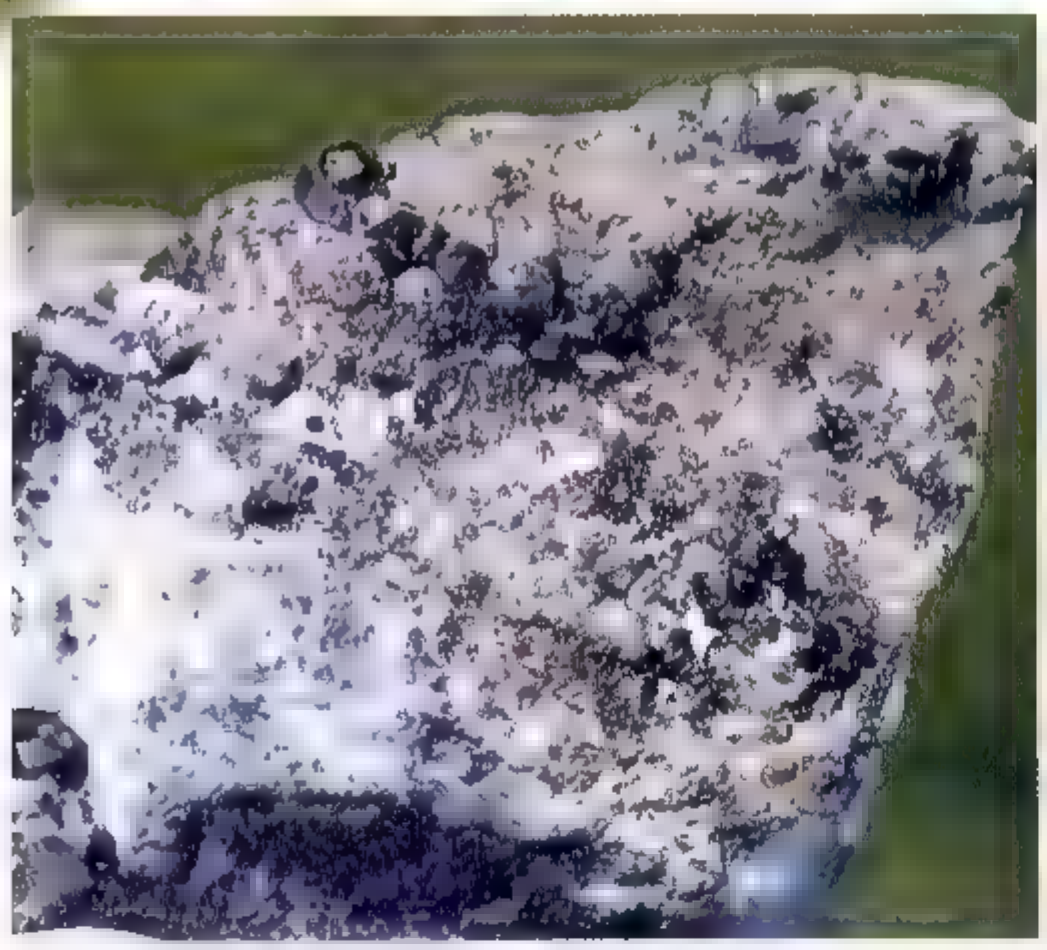
Hematite, Garnets and Chocolate in South-Central Pennsylvania

Story and Photos by Robert Beard

Hershey, Pennsylvania, is known around the world for chocolate. During the summer, the odor of chocolate permeates the air as you drive through downtown. This was originally a factory town, but since the main product is chocolate and not steel or automobiles, most people do not appreciate the fact that this is an industry and can be a dirty business.

Once you leave the town, you are often reminded why Milton Hershey decided to build his chocolate factory in this part of Pennsylvania: fresh milk from the local dairies. As you drive away from Hershey, the smell of chocolate sometimes gives way to the smell of manure. However, this should not keep you from visiting Hershey.

Long before Hershey built his chocolate factory, there were other industries in the area. During the mid-1700s to early 1800s, local iron manufacturers in the region were supplied by iron ores from near-surface deposits that were found in many places in south-central Pennsylvania. The abundance of wood (for charcoal) and limestone, also important ingredients in iron making, made the region a key producer of iron in the early days of the United States. Another significant industry from the late 1800s to the early 1900s was stone quarrying. Nearby brownstone quarries supplied



Well-crystalized, dark garnets are sometimes found with the specular hematite.

Hematite-covered rocks even stand out in the leaves during fall collecting

dimension stone that was used for buildings in many major American cities.

Much of south central Pennsylvania is relatively flat, but there are hills. As one heads northwest of Harrisburg into the Valley and Ridge Province of the Appalachian Mountains, the landscape is thrown into greater relief. The landscape southeast of Harrisburg is relatively flat as you are heading into the relatively softer, more easily eroded Paleozoic and Triassic sediments on the northwest side of the Piedmont Province of southeast Pennsylvania.

The flat topography of the Piedmont is often broken up by rounded, densely forested hills. While it is always important to never assume too much in geology, these rounded hills are often hard, resistant masses of diabase that intruded the Triassic sediments in the region. The diabase and most of the intruded sediments, which are mainly reddish siltstones sandstones with some minor areas of carbonates and conglomerates, are believed to be Triassic to Early Jurassic in age.

The diabase that intruded the sediments brought a tremendous amount of heat into the surrounding rocks. Diabase intrusions, which are rich in iron and manganese, are generally deficient in water compared to granitic intrusions, as they have not been enriched in many of the lighter elements. In addition, the sediments that they intruded were often fast siltstone and sandstone, so the potential for significant mineralization was limited.

However, where conditions were right, the diabase contacts with the Triassic sediments were often the site of significant iron mineralization. The iron minerals that formed were often magnetite and specular hematite. "Specular" hematite has a shiny, silvery appearance that resembles stainless steel. In areas in which the sediments contained carbonates or conglomerates, the heat and limited fluids from the diabase were able to react further with the sediments and form additional minerals such as garnet.

The early iron miners did not have an understanding of the geology, but they were very good at finding iron ore. The mineralization was likely spotted by early prospectors as heavy pieces of magnetite or as shiny, silvery flecks of specular hematite in the soil or in outcrops. Some of the early prospectors were undoubtedly disappointed to find that the shiny hematite was iron and not silver.

Some major iron mines were developed in the area. The largest and best known was the Cornwall Mine, located approximately 15 miles east of Hershey. The Cornwall deposit was mined until 1972, when the flooding from Hurricane Agnes overwhelmed the pit. Economic conditions did not make it favorable to reopen the mine, and it is now a large lake. Local mineral clubs are able to gain access to the dumps and minerals by the side of the lake for field trips, but the lake is fenced off and inaccessible to the casual collector. The dumps on the opposite side of the road near the lake can often be accessed by collectors, and produce good pieces of magnetite.

The Grace Mine was another large iron mine, located approximately 50 miles east of Hershey and just north of Morgantown, Pennsylvania. The Grace Mine was discovered by aeromagnetic surveys in the 1950s and became an important iron producer for Bethlehem Steel. However, Venezuelan iron soon became cheaper to import, and the Grace Mine closed in 1977. The Grace Mine is also occasionally open to collectors and should be visited if you ever get the opportunity.

By comparison, there was little exploration for iron in the diabase intrusions near the Hershey area. A relatively small intrusion of diabase has intruded the sediments along Bullfrog Valley Road, and this has resulted in some local iron mineralization. The hills on the east side of Bullfrog Valley Road are dotted with the remains of shallow mining pits, and these may represent some of the earliest industrial activity in the Hershey area.

The area is mentioned as the "Hummelstown Hematite" locality in the Third Edition of General Geology Report 33 of the Pennsylvania Geological Survey, titled "Mineral Collecting in Pennsylvania," by Davis M. Lapham and Alan R. Geyer (1969). It is the only site listed in Dauphin County in this publication, and a later version, published in 1976, did not mention it. I refer to it as the "Hershey hematite deposit" because it is close to Hershey, and Hershey is a much better-known town.

I have been to this site many times over the years, and have always returned with nice pieces of specular hematite and garnets. The garnets are generally very small, but often well crystallized, as seen when viewed with a hand lens. The site is just south of Bullfrog Valley Park and on the east side of Bullfrog Valley Road in the woods.

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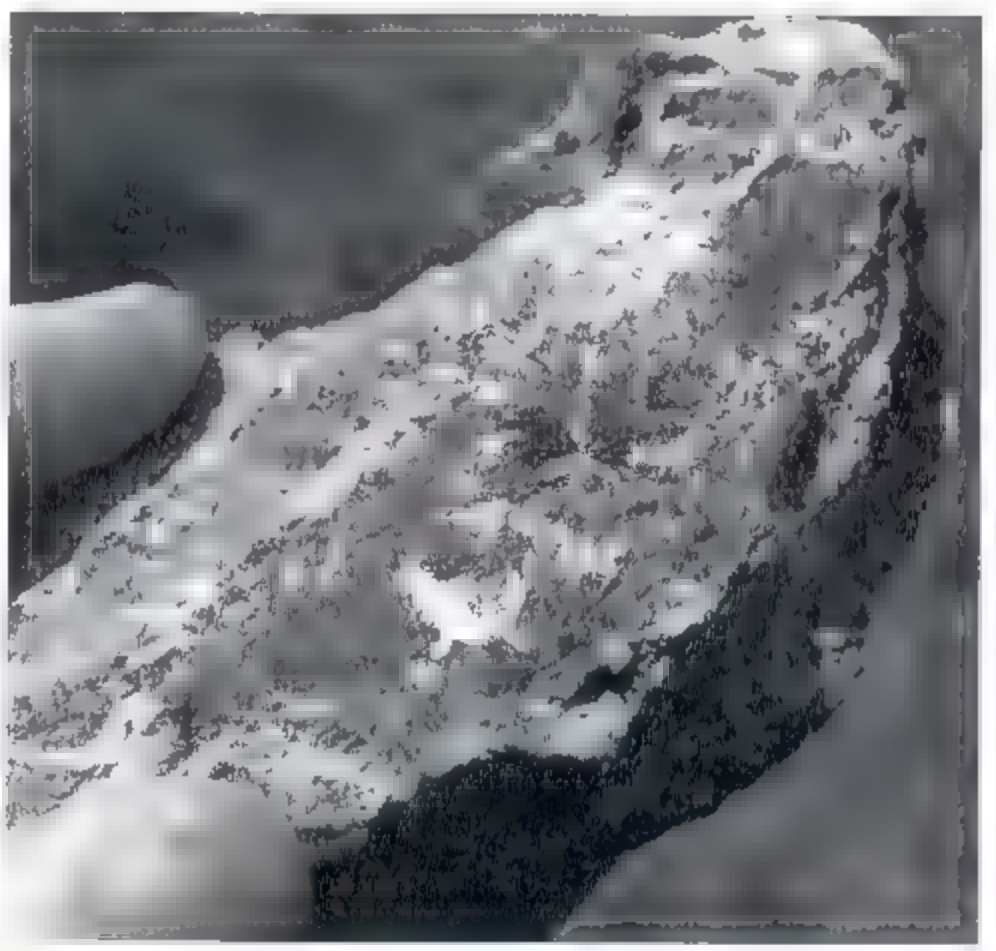
The old diggings are still visible as shallow pits on the sides of the hills



Breaking open the rocks often reveals radiating blades of specular hematite.

The location is easy to find, the entrance to the trail into the woods is marked by a small pad of asphalt for storm water drainage. I have never seen any "no trespassing" signs, but there is a prominent "no hunting" sign near the path. The area appears to be fairly well traveled by hikers and families that leave the boundaries of the park. The former mines are apparently so old and small that they do not show up on the USGS 7.5-minute topographic map, which is the Hershey, Pennsylvania, map.

The first time we visited the site was in the early 1990s. I went with my wife before we had kids. Fortunately, it was a very easy hike. A major source of friction in the early days of our relationship was going on long hikes for camping, fishing, and rock collecting, and since this was a short hike, I did not get into much trouble. We found quite a bit of specular hematite, and I was surprised to see that there were numerous prospect pits in the area. The interiors were covered with leaves and soil, and some of them had large trees growing inside them. Unlike the prospect pits I was familiar with from metal mines in the western United States, there was relatively little excavated dump material in which to look for minerals. The pits looked very, very old.

I returned by myself several times, and found that the best hematite was in a soil bank on the north side of the trail next to the entrance. I looked in many of the pits and elsewhere in the area, and even though I could find many pieces with specular hematite, the best and biggest pieces were the ones in this soil bank. Given its location and the fact that all the hematite was found in loose rocks, I suspected that this may have been the extension of a large tailings or processing pile.

Since these rocks were in soil, I washed them off when I got home. Most were heavily weathered and of rather poor quality, but I found that many had "books" of specular hematite, and these were often quite shiny. One of the rocks, however, really stood out. It had some excellent bladed masses of specular hematite, but most significant, it had extremely well-developed crystals of garnet. The garnet was dark brown, nearly black. The crystals were small, about 2 millimeters at the most, but it was a very striking piece. I had to have more of them.

Our latest visit was on Jan. 28, 2006. This winter in Pennsylvania was very unusual, as we had a relatively warm January and a warm period for much of February, but it was brutal the rest of the season. It was a near perfect day, and since the Hershey hematite location is so close, I was able to convince my wife and kids to go rock collecting.

We parked at Bullfrog Valley Park, which was packed with cars and families. The trails and the duck pond had an abundance of people, which I thought was great, it meant fewer people would pay attention to us as we got ready for rock collecting. The kids and my wife walked to the pond, and I got our buckets ready. I brought a 5-gallon bucket, two hammers, a chisel, strong gloves, and three bottles of water. As expected, my wife began to complain that I was taking too long, but we were soon ready to go.

We hiked up the road to the entrance with the storm drain, and I was extremely pleased to see that there still weren't any "no trespassing" signs. We waited for the right time to cross the road and walked up the slope into the woods. This is a busy road and you must be very careful when crossing it.

Right away, the kids began to run up the sides of the hills. This was a relatively safe place for kids, as there are no open mines or cliffs that they can fall off. I began digging in the soil bank where I had found pieces before, and right away found a huge piece that had big zones of specular hematite. I had also brought my GPS this time, and the location of the bank was 40.25640° N, 76.68239° W in degrees, decimal degrees format. I later smashed apart this piece and found that many of the areas of hematite also had abundant masses of fine-grained, orange-brown garnets.

We continued up the path, which increased in elevation as we went farther into the woods. As during previous visits, we saw many old prospect pits. Many of the pits had some large rocks on the slopes outside of the pits, and we found some beautiful pieces of hematite on some of the rocks. Interestingly, the specular hematite was silvery and dark gray, and there were practically no areas that were red, even though hematite has a red streak and is an oxidized form of iron.

Farther upslope, we came across some areas where the trees had been cleared and had not grown back. The soil in these areas was often filled with small fragments of specular hematite. I did not find any additional zones with garnet here. By

the time we finished collecting, we had a bucket full of excellent pieces of specular hematite and small garnets.

Based on my experience at the site, I think the best hematite and garnet are at the soil bank to which I provided the GPS coordinates. This is a very easy location to find, considering that the area is mostly woods, and should continue to provide good pieces of hematite and garnets for the foreseeable future. If it is part of a rock dump, there may be even more good pieces that could be exposed by additional digging.

The brownstone quarries mentioned earlier are also near this site. They are about two miles south of Hummelstown, and a little over one mile southwest of the iron mineralization along Bullfrog Valley Road. These quarries operated from 1867 to 1929, according to information from Hummelstown Borough (www.hummelstown.net). They are clearly marked on the Middletown, Pennsylvania, 7.5-minute USGS topographic map. Unfortunately, they are not only on private land, but have a camera stationed at the parking area to record any trespassers. Getting permission to visit these quarries obviously requires some inside contacts.

To go to the specular hematite and garnet site, take U.S. Highway 322 and turn south onto Bullfrog Valley Road, which is just west of the Hershey Medical Center. Continue south on Bullfrog Valley Road until you reach Bullfrog Valley Park, which is on the west side of the road. Park at the parking lot and walk approximately 300 feet south along Bullfrog Valley Road until you see a small asphalt drainage channel on the east side of the road. Cross the road and follow this channel up the hill.

You will see a path that leads into the woods and then some of the small prospect pits on the sides of the path. Watch the ground, and you will find pieces of specular hematite. Anyone who visits this site should also be aware that access for collecting can change at any time, so make certain that you are not on land that has been newly posted against trespassing.

This makes a good family trip as you can take your kids to the nearby duck pond in Bullfrog Valley Park, and the parking lot is very safe and secure. Just make certain that you are extremely careful crossing the road, as this is undoubtedly the most dangerous part of this trip. You should also be aware that, if you are with kids or chocolate-addicted people, you will almost certainly be required to go to Hershey for chocolate, but there are few better ways to finish a field trip.

Rock Science

Steve Voynick

Tracing Turquoise Origins

The mineral specimens and artifacts that archeologists recover from cultural sites had a broad variety of uses—everything from gemstones and gems to trading materials, talismans, and tools. Knowledge of precisely where these materials originated provides great insight into ancient cultural and economic relationships and the scope of prehistoric trade routes. Determining the origin of these minerals even offers a basis for chronological dating.

Of all recovered mineral artifacts, those made of turquoise may be the most archeologically significant, especially in North America and Central America. Since the late 19th century, archaeologists have been excavating turquoise artifacts from cultural sites in such geographically divergent areas as the southwestern and southeastern United States, Canada, the Caribbean, and northern Central America. Based upon its general appearance, many archeologists believe that most of this turquoise had a common origin: the legendary turquoise mines at Cerrillos, New Mexico, just south of the present-day city of Santa Fe.

After beginning production around the year 900, the Cerrillos mines provided turquoise for the Chaco Canyon culture of northwestern New Mexico, whose craftsmen fashioned large quantities of turquoise beads and pendants for use as a trading commodity. Anthropologists even attribute the rapid cultural development that occurred at Chaco Canyon between 1150 and 1280 to prosperity derived from the turquoise trade.

Because turquoise only occurs in very shallow deposits, pre-Columbian Native Americans in the Southwest had certainly discovered deposits other than those at Cerrillos. Cerrillos, however, was by far the most important early turquoise source. In order for archaeologists and anthropologists to prove that Cerrillos turquoise had played a major role in the development of the Chaco Canyon culture and its related continental turquoise-trade network, they must positively establish that the turquoise artifacts recovered from various cultural sites originated at Cerrillos.

Determining the origin of turquoise solely by visual inspection is possible only with certain larger matrix specimens. That is because the matrix material, and not the turquoise itself, tends to have a distinctive appearance. Unfortunately, small bits of turquoise such as beads and inlay, which usually have the greatest archaeological value, rarely include matrix material.

In these cases, positive source identification requires some type of laboratory analysis. In the early 1900s, researchers first attempted to determine turquoise origin with simple quantitative and qualitative chemical analyses. That approach failed because turquoise, a secondary mineral formed by mineral-laden solutions of varying chemical content and in differing deposition conditions, typically has a wide range of chemical and physical properties, even among specimens from the same deposit.

In the 1950s, researchers began employing advanced identification methods such as spectrographic analysis in the hope of recognizing unique, source-specific spectrum-emission patterns. When that failed, they tried analyzing Cerrillos turquoise specimens using advanced X-ray fluorescence, X-ray diffraction, arc-emission spectrometry, neutron-activation, and electron-microprobe methods.

In the late 1990s, still unable to positively identify turquoise by its source, researchers tried computer analysis of the mathematical values of turquoise's chemical components, hoping to establish "fingerprint" patterns. Next, they attempted to measure the traces of isotopic lead that are always present in turquoise. Again, the results were inconclusive.

Today, researchers are focusing on ion-microprobe analysis of hydrogen and oxygen isotopes. All turquoise contains measurable, but varied, ratios of hydrogen and oxygen isotopes that reflect the hydrogen-oxygen isotopic ratios in the rainwater or snowmelt that formed the turquoise deposits. Because these ratios appear to be site-specific, they may constitute a chemical "fingerprint" that is unique to each turquoise source.

Although work remains to be done, researchers believe that they will soon be able to positively trace the origins of turquoise. If so, we may soon have a better understanding of the origin of some of our prized turquoise specimens.

ROCK SHOP SPOTLIGHT:

THE ROCK DOC

The Rock Doc rock shop sits in the shadow of Mount Antero, a world-famous Colorado collecting site.

A Required Stop for Chaffee County, Colorado, Collectors

Story and Photos by Steve Voynick

Most great mineral-collecting areas have a great rock shop, and Colorado's Chaffee County is no exception. Chaffee County, located in the central Colorado Rockies about two-and-a-half hours of driving time southwest of Denver, has an unusually large number and variety of collecting localities. These include Mount Antero, the continent's highest gem field which is famed for its facet-quality aquamarine; Ruby Mountain, a noted source of topaz and spessartine garnet; the Badger Creek peridot locality; and many recreational gold-mining sites, one of which is the nation's highest-elevation operating gold mine. Centrally located among these and other Chaffee County collecting localities is The Rock Doc, which more than lives up to its billing as "The Biggest Rock Shop in the Rockies."

Each year, Chaffee County collecting sites attract hundreds of local and visiting rockhounds. For many, The Rock Doc is their first and last stop—first, to ask advice and purchase equipment, and last, to show off their finds. During the height of the summer collecting season, as many as 250 people visit The Rock Doc daily.

"The Rock Doc" is more than the name of a rock shop. It's also the nickname of Cindy Peratt, who owns and operates the shop with her husband, Dirk. Cindy is eminently qualified to discuss and offer suggestions regarding local minerals, gemstones, geology, and collecting opportunities for two reasons. First, she is a geological engineer; second, she is personally familiar with all local mineral localities. For Cindy, making the transition from geological engineering to running the biggest rock shop in the Rockies is a dream come true.

Earth science was not Cindy's first career direction. Born and raised in the Denver area, Cindy enrolled in Denver's Metropolitan State College to work toward a degree in accounting.

"But I got bored with accounting," she admits. "When it came time to choose classes for a new term, I wanted something different. So I sort of threw a dart and took chemistry and geology."

Cindy found chemistry and geology so interesting that she transferred to the nearby Colorado School of Mines, a prestigious engineering, earth-science, and resource-development institution. She went on to graduate with a bachelor's degree in geological engineering in 1986.

"After graduation, I wasn't interested in petroleum," Cindy says, "so I went into the environmental field, moving to Salt Lake City to work in bioremediation of industrial and liquid wastes to produce topsoil for landfill-reclamation use."

But by the mid-1990s, Cindy realized that she just wasn't thrilled with the corporate lifestyle and that life was about more than making money. She was still uncertain exactly what she wanted to do, but the idea of running a rock shop—pursuing her love of minerals while freeing herself from the corporate lifestyle—seemed particularly appealing.

Cindy had become interested in minerals at the Colorado School of Mines. "My advisor, Dr. Sam Romberger, also taught my basic geology class," Cindy recalls. "Sam had a way of making geology come alive, and I have been fascinated with rocks and minerals ever since."

But running a rock shop remained a dream as Cindy moved back to Denver in 1997, this time to work in the field of hazardous-waste and chemical cleanup. While in Denver, Cindy met her husband-to-be, Dirk Peratt, at a 20-year high-school reunion. A broadcast engineer, Dirk worked with television stations across the state. When his company asked him to relocate to a town near the geographic center of Colorado, both Cindy and Dirk eagerly headed into the mountains.

"We moved to Buena Vista in 2000," Cindy recalls, "and just a few months later, Dirk was laid off. We had to do something, but the area offered few professional job opportunities. Dirk suggested we take out a loan and open a business."

In June 2001, Cindy and Dirk visited the Prospector Rock & Gift Shop, a rock shop located 12 miles south of Buena Vista that had been a local landmark since its founding in 1970.

"And there was a 'For Sale' sign in the window," Cindy remembers. "Not only was this a chance to start our own business—but the business would be a rock shop. Dirk and I talked it over, and it seemed right for us. It was an established business and the location—right on a major highway near popular mineral-collecting localities—seemed ideal. We bought it three weeks later."

The Prospector Rock & Gift Shop quickly assumed a new name, The Rock Doc, after the nickname Dirk had bestowed upon Cindy shortly after they had met. Taking over a popular rock shop at the start of the summer "high season" proved to be quite a learning experience.

"Retail was new to us both," Cindy says. "Between handling the customer load and keeping up with the administrative end of things, we had our hands full and were holding on for dear life."

After that first hectic summer, Cindy and Dirk began rearranging the shop to suit their personal tastes. The main change was downplaying the gifts and placing much greater emphasis on mineral specimens and equipment for collecting, prospecting and mining.

Cindy built up the mineral inventory with specimens from around the world, while emphasizing material from Colorado and especially from local collecting sites. Meanwhile, Dirk expanded the inventory of collecting, prospecting and mining equipment, choosing lines and items that are particularly suited for the many nearby collecting localities.

Cindy Peratt, also known as the "Rock Doc," acquired her love of rocks and minerals at the Colorado School of Mines.

Together, the couple also visited and familiarized themselves with the nearby sites and spoke with experienced local collectors.

In 2004, Dirk put this fieldwork to use by writing an informative brochure titled "A Guide to Rockhounding and Prospecting in Chaffee County." This free brochure provides thumbnail sketches of more than two dozen collecting sites, along with a Chaffee County map. With the support of the Chaffee County Gem & Mineral Society and local jeweler and gemologist Mark Krivanek, Dirk printed 5,000 copies of the brochure. All were snapped up in less than two years, and Dirk is now in the process of reprinting the popular pamphlet.

"Along with listing collecting sites, the brochure emphasizes the legal and environmental considerations, as well as the ethics of mineral collecting," Dirk explains. "In areas like ours where we have an abundance of collectors and collecting sites, it's particularly important that rockhounds respect private land, mining claims, and federal regulations, and conduct their activities in an environmentally sensitive manner. After all, the way in which rockhounds conduct themselves today will determine the accessibility of collecting sites in the future."

At first glance, The Rock Doc appears more like a mineral museum than a rock shop. That's because of the shop's unusual dimensions. It measures just 11 feet in width, but 200 feet in length—all of it lined with display cabinets and shelves that are filled with mineral specimens and collecting equipment.

The Tool Room, which occupies the north end of the shop, is crammed with rock picks, hammers, chisels, collectors' packs, tumblers, laps, saws, abrasive grits, and polishes. Much Tool Room stock is aimed at gold prospectors and miners and includes pans, sieves, 2-inch and 4-inch dredges, sluices, metal detectors, and even selected diving equipment. The shop is an authorized dealer for such manufacturers as Minelab, Keene, Lortone and Estwing.

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The Rock Doc has more than 2,000 specimens from local, Colorado and worldwide locations.

This cabinet holds specimens from two of Colorado's best-known localities: Sweet Home Mine rhodochrosite and Mount Antero aquamarine and smoky quartz.

"Most creeks in this county are gold-bearing," Dirk says. "On summer days, as many as 10 dredges will be working on the Arkansas River and its tributaries, so we stock a lot of parts. We're the only place to buy parts for diving and dredging equipment within 100 miles. And folks spending their weekend or vacation time looking for gold don't want to waste a day driving when they need parts."

The shelves of the Library, adjacent to the Tool Room, are filled with more than 100 different books, most focusing on Colorado and local mining, minerals and geology. Also available is a selection of topographical maps that cover all local collecting sites and placers.

Most of the 2,200-square-foot shop is devoted to minerals. Among the more than 2,000 pieces on display are cabinet specimens from Cindy's personal collection. The remainder are grouped geographically as worldwide, Colorado or local minerals. The local minerals include fine examples of exactly what many collectors will be looking for: aquamarine and smoky quartz from Mount Antero, spessartine garnet and topaz from Ruby Mountain, peridot from the Badger Creek locality, garnet from the nearby Sedalia Mine, epidote and non-gem sapphire from the Calumet Mine, and gold from the Arkansas River and its tributaries.

"There is a misconception that our local placers yield only fine gold," Dirk says. "Actually, in many places the gold can be quite coarse. Two years ago, one of our regular customers recovered a 13-gram nugget."

Colorado specimens on display include Sweet Home Mine rhodochrosite, Crystal Peak amazonite, Silverton rhodonite, Hartsel and Stoneham barite, turquoise from several of Colorado's five turquoise occurrences, amethyst silver ore from the Creede district, pyrite from the old Eagle Mine at Gilman, and molybdenite ore from the Climax Mine near Leadville.

Prices range from 50 cents for "show-and-tell" specimens for the younger crowd to as much as $4,000 for museum-grade cabinet specimens.

"We keep our prices as low as possible," Cindy says. "Nearby shops in Aspen, Vail and Breckenridge also offer fine mineral specimens, but because of the high resort-town overhead costs, many are priced beyond the reach of the average collector. But with much lower overhead costs, we can make our specimens much more affordable. And that encourages folks to build mineral collections, which is good for the hobby."

The Rock Doc's clientele fall into two general groups. Half are tourists who are attracted by the big Rock Doc highway sign. The others are serious rockhounds, both locals and travelers from around the country and the world.

Owners Dirk and Cindy Peralt try to make mineral collecting fun, affordable, and a learning experience for their customers.

"Chaffee County is popular among rockhounds because it has sites suited for every level of field-collecting experience," Cindy says. "Ruby Mountain, as an example, is a great family-collecting site. It's easy to reach, has great scenery, and everyone is almost certain to find garnets."

But the biggest local draw is 14,269-foot-high Mount Antero, just six airline miles west of The Rock Doc. On summer days, as many as 100 rockhounds will be searching its high slopes for aquamarine, smoky quartz, and phenakite crystals. That doesn't include some two dozen prospectors who own mining claims on the peak.

"Antero draws folks from all over the country, and not all first-time visitors have a realistic idea of the conditions on the mountain," Dirk explains. "Some folks will fly into Denver, rent a car, and assume that it will get them up the mountain. When they stop by and tell us that they are headed for Antero, the first thing I ask is, 'What are you driving?' Even if they have a four-wheel-drive vehicle, I point out that the road is narrow, rough, and steep, and that alpine weather can change rapidly. I tell them the latest road and snow conditions, and ask that they be aware of the possibility of altitude sickness. Knowing these things in advance can make or break a collecting trip to Antero."

In 2004, Mount Antero received attention throughout the international mineralogical community when local collector Steve Brancato, who often visits The Rock Doc, opened a small pegmatite pocket and recovered more than 100 aquamarine crystals, including a magnificent, 6-inch-long, gem-quality prism. That crystal and others in a restored matrix specimen made the cover of *Rocks & Minerals* and were a big attraction at the 2005 Tucson Gem & Mineral Show.

"Since then," Dirk notes, "we're seeing more collectors than ever on Antero."

In addition to collectors, The Rock Doc welcomes a growing number of school groups each spring.

"The kids are from kindergarten through fifth grade," Cindy explains. "First I round them up in a group and explain the basics of rocks and minerals, then I pass specimens around. Many kids are amazed to learn that some of these eye-catching specimens were collected at sites near their homes. It's really neat to see that spark of interest in their eyes."

The Rock Doc also stocks an array of children's books, games and toys related to rocks, minerals and fossils. "I don't think it's ever too early to interest kids in the world around them," Cindy says. "After all, today's kids will be tomorrow's rockhounds and earth scientists."

What is the biggest reward that comes from operating The Rock Doc?

"It's knowing that we're helping to make mineral collecting fun, affordable, and a learning experience," Cindy replies. "Personally, I also get a lot of satisfaction when our customers return from Mount Antero, Ruby Mountain, or the gold placers to show us their finds. I enjoy sharing their sense of satisfaction and accomplishment, knowing that we had something to do with it."

The Rock Doc is located in central Colorado's Chaffee County, 120 miles southwest of Denver and midway between Buena Vista and Salida on U.S. Highway 285. The shop is only five miles south of the junction of state Route 162, the well-traveled turnoff for Mount Antero.

From Memorial Day through Labor Day, The Rock Doc is open weekdays from 9 a.m. to 6 p.m., Saturday from 9 a.m. to 5 p.m., and Sunday from 10 a.m. to 5 p.m. During the off-season, the shop is open Monday, Thursday, Friday, and Saturday from 10 a.m. to 5 p.m., and on Sunday from noon to 5 p.m.

For further information, write to The Rock Doc, 17897 U.S. Highway 285, Nathrop, CO 81236, call (719) 539-2019, or visit www.therockdoc.net.